WHATEVER HAPPENED TO BENEFIT-COST ANALYSIS?

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The editor of these commentaries urges the participants to start off with a brief statement about how we became involved with water resources. In my case, I guess you could say it all started on tractor seats and grain combine platforms in west central Texas. I spent what seemed like endless hours guiding and nursing these mechanical beasts while watching every, even slightly, promising cloud in the hopes of a rainstorm or even shade. The area, while far from a desert, seems perpetually in need of rain. The interactions of man and Mother Nature were a daily drama of great significance to our welfare. I carried my interests in these matters through my formal education; but of course, at the time there was no such academic field as natural resource economics, not to mention environmental economics.

With my first professional position, the involvement of my academic interest in these matters began to develop. John Krutilla's influence on me and on my professional development started even before I knew him personally. The first economics book that I read after graduate school, other than textbooks for the courses I was teaching, was the volume that he and Otto Eckstein published in 1958: *Multiple Purpose River Development: Studies in Applied Economic Analysis*. It was only the second book about water resources to come out of an exciting new organization called Resources for the Future (RFF). At that time I was a fledgling assistant professor of economics at the University of New Mexico, and, among the many other pieces of luck that have been my good fortune, my department chairman there was Nathaniel Wollman, then still in the early years of his career, later one of the nation's distinguished figures in water resources economics. He knew John, and lent me a copy of *Multiple Purpose River Development.*

During that time Nat Wollman and I worked on a project funded by the first grant by RFF to an outside body in the water resources area. The study dealt with the economics of allocating New Mexico's share of the Upper Basin entitlement to water from the Colorado River under the terms of the Law of the River. To give younger readers an idea of how long ago this was, if not in elapsed time at least in terms of technology, one of the capital items we acquired for this project was a brand new Marchant mechanical desktop calculator. We were very proud of it because it had a motor and therefore one did not have to pull a handle to set the gears whirring. This study (after a long editorial delay) resulted in the book *The Value of Water in Alternative Uses* (Wollman 1962).

My good fortune continued in 1960 when John Krutilla and Irving Fox, then co-directors of RFF's water program, asked me to join them in the development of a water quality program at RFF. This, in my view, was the greatest piece of good luck of my whole professional life. I will say a little more about this later. But since my professional career now spans about fifty years and has involved several universities and other institutions as well as RFF, my sample must be slim.

Our editor suggested that we select three areas in which, in one way or another, we have or have had an interest and discuss them. I will frame mine in the form of three questions.

1. Whatever happened to benefit cost analysis?
2. Why was systems analysis not more effective?
3. Do we need more flute music?

I will conclude with a brief comment on the by now quite maturely developed field of environmental (including water) economics.

WHATEVER HAPPENED TO BENEFIT COST ANALYSIS?

In 1808, Jefferson's Secretary of the Treasury, Albert Gallatin, brought out his report on a transportation (navigation) program for the new nation, and from that time to the present, public water development agencies have found it necessary and desirable to systematically compare estimated benefits with the costs of proposed development projects. The federal Reclamation Act of 1902 required economic analysis of projects; the Flood Control Act of 1936 established the welfare economics feasibility test that benefits "to whomsoever they may accrue" must exceed costs. In 1946 the Federal Interagency River Basin Committee (FIARBC) appointed

a subcommittee on benefits and costs to reconcile the practices of federal agencies in making benefit-cost analyses. Four years later this subcommittee issued a landmark report entitled *Proposed Practices for Economic Analysis of River Basin Projects* (Federal Interagency River Basin Committee, Subcommittee on Benefits and Costs, 1950). While never fully accepted either by the parent committee or by the federal agencies, this government report was remarkably sophisticated in its use of economic analysis; the intellectual foundation that it laid for research and debate in the water resources area set it apart from other major reports in the realm of public expenditure. As most readers of *Outlook* will know, it was fondly known by two generations of resource economists as the "Greenbook."

By the time this codification was published, the evaluation of "conventional" outputs of water resource projects had become routine. They consisted of irrigation, navigation, flood control, hydropower, and municipal and industrial water supplies. A common feature of all of them was that benefits could be satisfactorily evaluated by ingenious applications of information generated by markets. Eckstein's *Water Resources Development* was an exposition and critique of these methods and an interpretation of them in terms of formal welfare economics. The result was that as benefit-cost analysis of water projects was at its peak of refinement few major projects were candidates for evaluation.

Benefit-cost analysis is, however, not dead; it just moved to other fields of activity. It is now widely, and in some cases mandatorily, applied to such matters as environmental policies, new technologies, and all sorts of government programs. Such evaluations have also spread abroad in a major way. While economists may well take pride in the high importance attributed by many to one of our tools (although it must be admitted that the early development was due to practical economists actually trained as engineers), my impression is that many of its new practitioners are unaware of the techniques, origins, and the rigorous theoretical foundation underlying it. Are we stretching benefit cost analysis beyond its reasonable limits? Does the whole field invite a fundamental reassessment?

WHY WAS SYSTEMS ANALYSIS NOT MORE EFFECTIVE?

In retrospect, one can see that Krutilla's *Multiple Purpose River Development* stood in the vanguard of an era of research on the applications of systems analysis to the economics of water resources development. The study was the first to provide a detailed description of the kinds of physical interdependencies that exist in river basins and which must be taken into account if efficient development is to take place. It went on to apply this analysis in several case studies.

The apogee of this line of research was, however, the Harvard Water Program. I had some small connection with it, and anyone not having had this experience would have difficulty understanding how exhilarating it was. Electronic digital computing technology was still relatively new, and the enthusiasm for applications of systems analysis, though in retrospect naïve, was almost boundless. These were heady times indeed. The key words can conjure them up – stochastic hydrology, mathematical programming, system simulations, Lagrangian analysis, decision theory. The culmination of this effort was the publication of *Design of Water Resource Systems* by Arthur Maass and associates (1962) in the Harvard water program.

Some of the methodologies (e.g. stochastic hydrology and mathematical programming) from the period of research that focused on integrated river basin development have continued to find applications. But the great edifice of economic systems analysis erected by the Harvard Water Program has stood largely empty since the *Design of Water Resource Systems*. This for two main reasons. First, although the physical opportunities existed, integrated river basin development proved to be a rare thing, even to the limited extent that it took place in the Columbia Basin studied by Krutilla. Much more typical is a disjointed process, with a project being planned, possibly authorized by Congress, and then later, often many years later, money possibly being authorized by Congress for construction, which, again, might be strung out over many years. Indeed, for many authorized projects money was never appropriated. River basin development simply has not been based on system optimization. Second, the studies discussed here, and implied earlier, proceeded during what was perhaps the peak of dam building in the United States (U.S.). But at the same time that era was already drawing to a close. Most of the good or acceptable sites for water projects had already been developed or were under active development. The attention of economists was beginning to be directed toward other aspects of water and other natural resources problems.

For reasons that I hope will soon be evident I have given the third section a somewhat whimsical name. Clearly it connects with the previous one.

DO WE NEED MORE FLUTE MUSIC?

Among the many pieces of good luck that blessed my career, I was pleased to have been able to participate in the founding of three of the main journals in the area: *Water Resources Research*, which was published by the American Geophysical Union; the *Natural Resources Journal*, which was published by the University of New Mexico Law School; and the *Journal of Environmental Economics and Management*, which is the youngest of the three but nevertheless about to have its twenty-fifth anniversary, published by the Academic Press and is the official publication of AERE (Association of Environmental and Resources Economists). That organization, which consists of environmental economists and people in closely related disciplines rather well-defined as environmental and economic management scholars, now is approaching a thousand members – which, for a focused professional organization, really is fairly considerable. It was a pleasure to have been involved in the development and nurturing of these journals and to meet some wonderful people in the process.

One of them was Walter Langbein, the now deceased dean of American hydrology, with whom I jointly founded *Water Resources Research*. Walter, by then quite elderly, had been one of the first to use modern mathematics (queueing theory, for example) in the analysis of hydrology problems, but had become a bit dubious about the degree to which complex modeling was taking over the field. We would get a paper for review with complex notation, double integrals for example; Walter would slap his forehead and exclaim, "Ach! More flute music." This was his subtle and humorous, but also serious, way of issuing a warning to the profession. The implied question was whether, because of its amenability to rigorous analysis, we had let method outrun content in the water resources field. Judging by a quick perusal of recent issues of *Water Resources Research*, that is still a valid question. Are our best and brightest being lured into the manipulation of rather sterile formalisms, and if so, what can be done about it?

REORIENTATION OF THE RFF WATER PROGRAM

Perhaps the major indicator of the reorientation of water resources research at RFF was the emerging perception that water quality problems might be just as worthy of economists' attention as the matter of water quantity. This development was in no small measure due to the insight and efforts of John Krutilla and his then codirector in the RFF Water Resources Program, Irving K. Fox. In early 1960, they hired me to develop a program of water quality studies for RFF. Both of them were extremely helpful and encouraging during my opening struggles, and in the early 1960s a program was in fact launched. The first major publication from this early effort was *The Economics of Regional Water Quality Management* (Kneese, 1964).

The Water Quality Program was very active in the early 1960s through the early 1970s, focusing on such matters as alternative policy instruments (e.g., effluent charges versus direct controls), methods for modeling the economics of regional water quality management, and institutions for water quality management. This research was instrumental in influencing water quality policy in several countries. A comprehensive report on the program is found in the RFF volume *Managing Water Quality: Economics, Technology, Institutions* (Kneese and Bower, 1968). Blair Bower was a major player in the reorientation.

In economic research, one theme of the seventies was that water was often seen in the perspective of a wider environmental or resource concern. For example, in the RFF Quality of the Environment Program, water quality was treated as one player in an integrated residuals management approach. There was heavy emphasis on trade-offs among residuals streams that could be discharged to alternative environmental media. The major case study performed during this period (Spofford, Russell, and Kelly, 1976), dealing with the lower Delaware valley, treated water quality issues in a model that handled land disposal, wastewater effluents, and atmospheric emissions at the same time.

These integrated environmental-economic models (some less complex ones were developed in other contexts) represented a promising beginning and indeed proved of practical value in the analysis of certain policy issues. One could argue that as we try to deal with increasingly subtle and long-term ecological-economic interrelations, regional modes of analysis take an increasingly large significance. But unfortunately, the basic federal water quality legislation of the 1960s and 1970s was increasingly based on a know-nothingism with respect to such matters as the spatial and interrelated characteristics of environmental systems – a situation which does not seem to be in a hurry to change. Nevertheless, I think the future of water resources research lies heavily in viewing water as a component of integrated environmental-economic systems.

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