Evolving Economic Analysis Techniques

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Abstract

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(*) Very good analysis and synthesis!
I wish I had your paper a week before the last class so that I could make copies and distribute to class since we didn't cover in class the Social Cost-Benefit Analysis.

(*) Do you have any MARR figure used for CBR?
I wonder if it is really low (which I expect)?

(*) If this COE Economic Justification with the New Guidance is still in the development phase and requires some methodological contributions, it may be very helpful to talk with Dr. Kavaoğlu. I don't know if you took EMGT.530 but he presents a hierarchical decision model which may be very helpful for you to contribute to the design of the valuation method.

The U.S. Army Corps of Engineers has played a key role in the economic development of this country. Most of the development has been in the area of water resources engineering projects. Corps of Engineer's (COE) water resource projects have been a linchpin of the nation's water resources management efforts. These projects have provided a variety of benefits including, port development, waterway navigation, flood control and hydropower generation. Historically, support for the COE's program was rooted in a national commitment to controlling the variability in watershed hydrology as a key to the nation's material prosperity. In this paper, I will compare and contrast different methods the COE uses to economically justify engineering projects

The Corps of Engineer's Planning Process

Before comparing and contrasting the old and new economic analysis methods being used by the COE, it is necessary to first understand the planning process that the COE uses. It is in the planning process that the economic justification of a project is calculated. It is mainly in the types of projects and the methods that the COE is using to justify these projects that change are being made.

The COE uses a four step process to build water resource projects. The four steps are the Reconnaissance Study Phase, the Feasibility Study Phase, Plans & Specifications Phase and the Construction Phase.[1] The first two phases constitute the planning portion of a project where economic analysis occurs. Projects are initiated in one of two ways. For smaller projects, a local group or entity can simply send a letter of

[1] *Guidance for Conducting Civil Works Planning Studies*, p. 2-1.

request asking for COE assistance to solve a water resource problem. For larger projects, the COE must be specifically directed by Congressional authorization to initiate the four step process. The Reconnaissance Study Phase must, by law, be completed in one year with a six month extension granted under unusual circumstances. The Feasibility Study Phase typically lasts two to three years before the project moves into the Plans & Specifications Phase which normally takes two more years before construction begins.

The Reconnaissance Study Phase has several purposes. Generally, its purpose is to determine if a project warrants in-depth study and the expenditure of larger amounts of Federal funds. The study is very limited in its scope and mainly relies on existing information to make the determination if the next phase is warranted. To prevent the expenditure of large sums of money, the length of the study is limited to twelve months and cannot exceed a certain percentage of the total cost of the project. Officially, the four objectives of a Reconnaissance Phase Study are:[2]

- Clearly define the water resource problem and potential opportunities and benefits
- Determine if one alternative has a Federal interest that warrants further study
- Estimate the time and costs required to complete the Feasibility Phase
- Assess the likelihood of obtaining non-Federal sponsors for the project

[2] Ibid., p. 3-9.

"Federal Interest" and Cost Sharing

Two areas from above that require further explanation are "Federal interest" and "non-Federal sponsor." A Federal interest in a project usually means that the project is economically justified and provides economic benefits for an entire region or multiple groups of people. Non-Federal sponsorship is a new concept for the COE. The Water Resources Development Act (WRDA) of 1986 requires that a non-Federal entity, usually a state or local agency, share a portion of the costs associated with studying and constructing water resource projects. This was a major change to the way the COE did business. Typically, a non-Federal sponsor must pay fifty percent of the costs of the Feasibility Phase and twenty-five percent of the Design and Construction Phases depending on the type of project. Reconnaissance Studies are still one hundred percent Federally funded. Cost sharing requirements have had mixed effects, but overall have been an improvement to the way the COE operates.

Traditional Economic Justification

The Reconnaissance Study either recommends that a project be terminated for lack of economic justification or engineering feasibility or it recommends that the Feasibility Phase be initiated. A Feasibility Study is similar to a Reconnaissance Study except that more time and effort is expended in the Feasibility Phase. Original data is collected, the alternatives are refined and more economic calculations are completed. The final outcome of the Feasibility Study is to find the project is justified or to terminate it at this point. These two phases make up the planning portion of project development

process. It is in the planning process that this paper will concentrate on comparing and contrasting different methods of calculating economic justification.

Within this planning process, economic justification is a key element. A project will go through an economic analysis in the Reconnaissance Study and the Feasibility Study before design and construction begin. The type of analysis that the COE has relied on is the use of a benefit to cost ratio (BCR). Projects with a BCR greater than one were considered economically justified. According to Federal planning guidance, "A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment."[3] Environmental impacts are considered from the perspective of insuring compliance with Federal and state laws such as the National Environmental Protection Act. Further, guidance states that economic benefits measured will be benefits that contribute to national economic development or NED benefits.

> Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed and also those that may not be marketed.[4]

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[3] *Guidance for Conducting Civil Works Planning Studies*, p. C-2.
[4] Ibid., p. C-1.

The alternative that is chosen is the one that maximized NED benefits and has a BCR greater than one. This selected alternative is known as the NED plan.

Selection of the NED plan worked relatively well for traditional flood control and navigation projects. It is easy to quantify in traditional monetary units the benefits of preventing floods in an urban area for example. Environmental impacts were considered in these analysis, but they were not given an economic value. As the political environment began to change in the 60's, other non-traditional projects began to be evaluated by the COE.

Restoration Projects and Economic Justification

Political changes and the realization that Corps projects were having adverse environmental effects severely curtailed the number of water resources projects the COE was able to build. The political environment today has continued this trend and the COE will probably not construct any new large water control structures. The emphasis has therefore switched to operating and maintaining the present infrastructure. The Corps administration of Section 404 of the Clean Water Act makes it the lead agency for protecting the Nation's wetlands. Further, the COE's control of large quantities of water in the reservoirs it owns and operates has caused a shift in thinking within the organization. The shift has been towards involvement in projects to restore environmental damage done by its projects. The control of the hydrology of entire watersheds also makes it a key player in other restoration projects as well.

The shift to environmental restoration projects has not been easy working within the old project planning process and using old economic evaluation techniques. The methods used have evolved within the old framework so that the COE can still apply it to traditional projects such as the deepening of the Columbia River Channel for the use of the Ports of Portland and Vancouver. Traditional economic analysis techniques can be applied very easily to these types of projects. The costs of deepening the channel are calculated and compared to the benefits of larger ships calling in Portland and efficiencies gained by the larger volume of cargo these ships can carry. When the COE first became involved in restoration activities, the BCR method and calculating NED benefits was applied without changes.

Applying this method to environmental restoration projects did not work. The main type of restoration projects the Corps is involved in is anadromous fishery restoration projects. This type of project will be used to show how the planning process has changed to accommodate restoration projects. Anadromous fish are fish that have a migratory lifecycle such as the various species of salmon and steelhead. COE dams on the Columbia, Snake and Willamette River Basins have adversely affected the ability of the fish to migrate naturally both as adults returning to spawning grounds and as juveniles migrating out to the ocean.

There is a great deal of uncertainty that is inherent in dealing with fishery restoration projects. The lifecycle of the fish and how different factors affect the lifecycle are not understood very well. This uncertainty makes economic analysis even more critical and difficult to accomplish. The COE process for completing economic evaluation of fishery restoration projects has evolved and continues to change as new policy is determined and tested in the field. The first salmon restoration projects were simply evaluated using traditional economic techniques and did not meet with very much success.

Traditional methods of economic evaluation concentrated on determining benefits in terms of the market value of increasing salmon runs. The engineering changes necessary to dams on the MacKenzie River (a tributary of the Willamette), for instance, are very costly compared to the number of returning adult salmon that the changes would produce. A commercial value for Spring Chinook was determined to be $2.25 per pound on the open market. Given the average weight of a Spring Chinook at eighteen pounds the average commercial value of a salmon was estimated to be $40.50 per fish.[5] Sport fishing market value was also used to quantify the benefits of the project. These recreational values were calculated from a study completed by Brown, Sorhus and Gibbs in 1980 that concentrated on the sport fishing industry in Oregon. The study based the value on travel costs and time as a proxy of the recreational experience as well as such factors as catch success, location and species taken. The

[5] *Willamette System Temperature Control Study, MacKenzie River Subbasin*, p. E-7.

resulting value used in this analysis was $135 per harvestable sport fish.[6] Given that improvements to the dams would create an increase of approximately 10,000 fish, the total net present value of benefits totaled $1.53 million. The construction cost of the changes to the dams totaled approximately $30 million plus the cost of foregone hydropower and recreation. The BCRs for this project were all significantly under one.[7]

The commercial and sport fishing values calculated using these traditional methods did not justify the huge expenditures necessary to improve passage at the dams. The requirement under the old planning guidance that projects have a BCR greater than one proved to be unattainable when applied to fishery restoration projects. The COE next tried to build non-traditional values into the benefit equation. Existence value concepts were applied to better reflect the true "market value" of fishery restoration.

New Corps of Engineer Planning Guidance

What became obvious from these attempts to justify restoration projects within the old planning guidance framework using traditional valuation techniques was that new guidance was needed if the COE was going to pursue environmental restoration projects. After a couple of years of development this need was answered with the publishing of "draft" environmental planning guidance in March of 1994. The policy,

[6] Ibid.
[7] Ibid., p. C-12.

titled *Environmental Restoration Guidance*, is a significant departure from traditional policy.

Perhaps the biggest change from old policy is the definition of Federal interest and what are the Federal objectives in environmental restoration projects. The Federal objective is no longer the alternative that maximizes National Economic Development benefits.

> The P & G [old policy]state that the NED plan is to be selected unless the Secretary of the Army grants an exception to selecting the NED plan when there are overriding reasons for selecting another plan based on Federal, state, tribal, local and international concerns, *which may now include the provision of environmental outputs* [italics added].[8]

Federal interest was gauged by how many net NED benefits could be gained from the project. That has also changed. "Projects for ecosystem restoration will not - in fact, cannot now, - be evaluated solely on the basis of net NED benefits."[9] The emphasis no longer has to be on how much more efficiency is gained in terms of increases in navigation or hydropower, but can be in terms of how much the project restores the ecosystem to its natural state.

[8] *Environmental Restoration Planning Guidance*, p. 7.
[9] Ibid., p. 18.

Even the use of the term "ecosystem restoration" is a change worth noting in itself. This indicates a basic shift in focus within the COE. While the COE has always looked at projects from a watershed perspective, looking at the entire ecosystem for restoration is new. As stated in the new policy, "The primary objective of ecosystem restoration is to emulate a former, natural, self-regulating system (in part or in total), in which plant and animal communities were in balance with each other and with their physical and chemical environment..."[10]

Another basic change in the new guidance relates back to establishing Federal interest in a restoration project. Added criteria include the significance of the habitat or species in terms of diversity, scarcity, whether it functions on its own, resiliency and tolerance to changes.[11] These are appropriate criteria that will more accurately measure the success of a restoration project. It is another shift from measuring a project by its net monetary outputs.

Recognizing the uncertainty inherent in environmental restoration projects is another significant step in the right direction. Former COE projects were straight-forward, by the book engineering endeavors that conformed to specific standards. From the new policy,

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[10] Ibid., p. 2.
[11] Ibid., p. 8.

> It must be recognized that there remains a fundamental scientific uncertainty about the theories and tools of ecosystem restoration. Hence, restoration projects cannot be formulated using the hard and fast application of engineering standards traditionally applied in other aspects of water resources development. Furthermore, the decision making approach for restoration must accommodate this uncertainty and attempt to improve the understanding of the relationships among the features and processes of the ecosystem being restored.[12]

The "accommodation" allows for adaptive management of restoration techniques to be used. This will allow restoration tools to be implemented as a demonstration to increase the level of knowledge regarding ecosystem restoration. It will enable the COE to rise above the differences in opinion prevalent in the scientific community and actually see if a technique works in practice. This could have far reaching impacts and application across a wide variety of watersheds if a technique is found to be effective.

Economic Justification with the New Guidance

Finally, the last significant difference in the new policy guidance is in the area of economic justification of projects. As mentioned above, some techniques may be implemented on a test basis without formal economic justification. Beyond this, the basic method of economic justification has changed with the adoption of this new policy. As already explained, the total emphasis on national economic development (NED) benefits has shifted and can be overridden for environmental outputs. No longer

[12] Ibid., pp. 4-5.

is a benefit to cost ratio (BCR) necessary to justify a restoration project. As a recent letter from the Army Corps of Engineers Headquarters in Washington, D.C., referencing the example used in this paper of the Willamette River Temperature Control Study, points out,

> The economic analysis should not include estimates of value of salmon in the willingness to pay sense. That is, no benefit-to-cost analysis should be undertaken. The analysis should focus on incremental cost effectiveness, including benefits foregone if relevant.[13]

An incremental cost analysis is completed instead of a BCR. The incremental cost analysis is a comparison of the additional costs and additional outputs associated with alternative plans and variation of alternatives. There is no longer a requirement to force a market value on a non-market good such as a wild salmon. Further, the economic justification may take more qualitative judgments into account when evaluating alternatives. For example, "Other qualitative comparisons could include the additional (incremental) cost associated with a plan that provides greater resilience or sustainability, or for one which more closely replicates the more desirable hydrologic regime or less disturbed ecological functions."[14] An incremental cost analysis that has environmental outputs as benefits instead of monetary benefits provides the COE the flexibility to complete important ecosystem restoration projects.

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[13] Bates, Chief, Policy and Planning Division, Army Corps of Engineers Headquarters, p. 3.
[14] *Environmental Restoration Planning Guidance*, p. 20.

Conclusion

The COE planning process and economic analysis techniques that it uses have evolved over the last ten years. Changes in the political environment have forced the COE to become more involved in environmental restoration projects. Old economic justification techniques made it difficult to complete the planning process and make changes to or build new projects that restored the environment. Recently, new guidance that has been released in draft form has increased the amount of flexibility the COE has to complete restoration projects by making economic justification move beyond the "market value" of outputs. "Market value" does not reflect the total value of restoring an ecosystem to a condition that more closely resembles its natural state. The contingent valuation method and other techniques to determine market value may have application where a company has severely damaged or destroyed an ecosystem by spilling toxic wastes, although the cost to restore the ecosystem may be a more appropriate way to measure damage. These techniques have not helped the COE justify ecosystem restoration projects. New economic analysis techniques and policy will help the COE pursue environmental projects that restore the variability back into watershed hydrology. Using these analysis tools will enable the Corps of Engineers to continue to provide engineering services to the Nation and repair the harm that some projects have caused the environment in the past.

BIBLIOGRAPHY

Bates, Jimmy. Director of Policy and Planning Division, U.S. Army Corps of Engineers Headquarters, Washington, D.C. Letter to Portland District. *Subject: Summary of Willamette River Temperature Control.* 15 January 1993.

Berry, Wendell. "Conservation Is Good Work." *The Amicus Journal,* Winter 1992, pp.34-37.

Dixon, John A., ed. *Economic Valuation Techniques for the Environment.* Baltimore: John Hopkins University Press, 1986.

Eberle, David and F. Gregory Hayden. "Critique of Contingent Valuation and Travel Cost Methods for Valuing Natural Resources and Ecosystems." *Journal of Economic Issues,* 25 (September 1991), 649-687.

Hayden, F. Gregory. "Ecosystem Valuation: Combining Economics, Philosophy and Ecology." *Journal of Economic Issues,* 27 (June 1993), 409-420.

----------. "Instrumental Valuation Indicators for Natural Resources and Ecosystems." *Journal of Economic Issues,* 25 (December, 1991), 917-935.

Krutilla, J.V. and A.C. Fisher. *The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources.* Washington, D.C.: Resources for the Future, 1985.

Olsen, Darryll, et al. *Existence and Sport Value for Doubling the Size of the Columbia River Basin Salmon and Steelhead Runs,* Study prepared for U.S. Army Corps of Engineers, Portland Oregon, January 1990.

Passel, Peter. "Polls May Help Government Decide the Worth of Nature." *The New York Times,* 6 September 1993, pp. 1, 20.

U.S. Army Corps of Engineers. Engineer Regulation 1105-2-100, *Guidance for Conducting Civil Works Planning Studies.* Washington, D.C.: GPO, December, 1990.

U.S. Army Corps of Engineers. Policy Guidance Letter No. 24, *Restoration of Fish and Wildlife Habitat Resources.* Washington, D.C., March 1991.

U.S. Army Corps of Engineers. Draft Engineer Circular 1105-2-206, *Environmental Restoration Planning Guidance.* Washington, D.C., March 1994.

U.S. Army Corps of Engineers. *Willamette System Temperature Control Study, MacKenzie River Subbasin.* Portland, Oregon, 1988.

U.S. Army Corps of Engineers. *Economic and Environmental Considerations for Incremental Cost Analysis in Mitigation Planning.* Washington, D.C., March 1991.

U.S. Army Corps of Engineers. *First Steps in the Development of a Method for Evaluating Environmental Restoration Projects.* Washington, D.C., September 1992.