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Broadening U.S. Water Resources Project Planning and Evaluation

We could fill a large room with documents drawing up what are considered the best plans for and analyses of problems in river basins around the world....On the other hand, the literature about what has happened after any of the projects have been carried out can be assembled on one end of a small table.

Gilbert F. White¹

ABSTRACT

U.S. federal water resources planning and evaluation activities have usually emphasized future costs and benefits of prospective projects. A detailed planning document, the Principles and Guidelines, guides U.S. federal water resources project planning. But no comparable document exists to guide retrospective, ex post reviews of water projects and programs.

Social goals and preferences may change substantially after project implementation. A lack of ex post evaluation may inhibit appropriate project and policy adjustments. Broadening U.S. water resources management to incorporate a greater degree of ex post evaluation may help resolve some of the nation's water resources controversies. The inclusion of independent scientists—who should work cooperatively with agency officials—can help ensure objectivity and credibility. Successful implementation of adaptive management, which is increasingly looked to for helping to resolve U.S. water policy challenges, may rely upon effective ex post evaluation.

I. INTRODUCTION

There is today a sense that the nation's water resources management organizations and projects are not adequately addressing contemporary water problems. Riverine and aquatic ecosystems in the United States have been altered substantially over the past century and have experienced changes in physical processes, losses of habitat, and declining populations

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1. *I GEOGRAPHY, RESOURCES, AND ENVIRONMENT: SELECTED WRITINGS OF GILBERT F. WHITE* 72 (Robert W. Kates & Ian Burton, eds., 1986).

of native species.² Powerful status quo interests defend current policy regimes and seek to maintain steady patterns in the delivery of river system benefits such as hydropower and navigation channels and pools. Other stakeholders seek significant management changes and call for greater input into the policy process and for greater agency accountability and flexibility. Management agencies are often caught in forces between legislative mandates, historical inertia, missions that overlap or are inconsistent with other agencies, a variety of interest groups, and scientific and ecological uncertainties. Often, at best, management agencies muddle through with small incremental changes; at worst, they are sharply criticized by all stakeholders. In some instances, stresses on water supplies and a lack of comprehensive interstate river basin plans lead to the promotion of state-specific interests at the expense of regional cooperation and sustainable water uses. These problems exist despite substantial resources devoted to avoiding them. How have we arrived at this situation?

U.S. federal water resources agencies are guided by a detailed and extensive "ex ante" (prospective) planning framework for future water project planning. By contrast, there is a near absence of formal "ex post" (retrospective) project management guidelines. Despite the potential benefits of incorporating past results into future planning and operations, agencies shun historical ex post reviews for several reasons: public criticism of projects under construction tends to inhibit project proponents from studying impacts, administrators tend to avoid exercises that might cast them in a negative light or be unduly expensive, water project effects are not always clearly manifest or understood, and the multidisciplinary knowledge required to comprehensively evaluate a project or program is rarely found within a single organization.³ Like individual U.S. water projects, formal ex post reviews of water resources organizations, policies, and programs have also been limited.

After project or program implementation, economic, environmental, and social conditions may change substantially. For example, many dams constructed in the western United States in the 1950s and 1960s were built primarily to produce hydroelectric power. With changing social and economic preferences, however, those dams today are often required to satisfy a broader range of purposes, including instream flow requirements and recreation. Despite some operational changes to these dams and the

2. See generally David Galat & Ann Frazier, *Overview of River-Floodplain Ecology in the Upper Mississippi River Basin*, in 3 SCIENCE FOR FLOODPLAIN MANAGEMENT INTO THE 21ST CENTURY (John A. Kelmelis ed., 1986); Wendell Minckley, *Native Fishes of the Grand Canyon Region: An Obituary?*, in COLORADO RIVER ECOLOGY AND DAM MANAGEMENT (1991); UNITED STATES GEOLOGICAL SURVEY, *ECOLOGICAL STATUS AND TRENDS OF THE UPPER MISSISSIPPI RIVER SYSTEM 1998: A REPORT OF THE LONG TERM RESOURCE MONITORING PROGRAM* (1999).

3. See Gilbert F. White, *The High Dam at Aswan*, ENV'T, Sept. 1988, at 38.

nation's water policies, however, it has been suggested that such changes are not keeping pace with changing environmental and social conditions and are contributing to unsustainable water uses.⁴ Although formal ex post evaluation in itself may not avert or repair degraded ecosystems, it could provide a standard process for deciding if and how operations are to be adjusted.

As social goals and environmental conditions evolve, water resources projects and programs should be adjusted appropriately. As the World Commission on Dams pointed out, "Dams and the context in which they operate are not seen as static over time....Management and operations practices must adapt continuously to changing circumstances over the project's life and must address outstanding social issues."⁵ Policy scientists William Ascher and Robert Healy have stated, "ex post assessment or appraisal bears the burden of signaling when and where resources are misallocated."⁶

Limited use of ex post assessments of water projects and programs may constitute a blind spot in U.S. water resources policymaking. Periodic ex post evaluation is essential in determining if objectives are being met and if resources are being wisely allocated. Without this information, it is not clear how operations and policies might be appropriately adjusted, which can hinder organizational learning and may contribute to organizational rigidity.

II. PRINCIPLES AND GUIDELINES

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, or Principles and Guidelines (P&G)*, were formulated by the U.S. Water Resources Council⁷ and represent the most comprehensive set of planning guidelines for U.S. federal water resources projects. The *Principles and Guidelines* document guides the planning of four federal agencies: the Bureau of Reclamation, the Corps of Engineers, the Natural Resources Conservation Service, and the Tennessee Valley Authority. The *P&G* describes procedures to be used in the planning of future water resources projects, including flood damage reduction, hydropower, and inland navigation projects.

4. See, e.g., AQUATIC ECOSYSTEMS SYMPOSIUM: A REPORT TO THE WESTERN WATER POLICY REVIEW ADVISORY COMMISSION iii-iv (Wendell Minckley ed., 1997).

5. WORLD COMMISSION ON DAMS, DAMS AND DEVELOPMENT: A NEW FRAMEWORK FOR DECISION MAKING xxxiv-xxxv (2000).

6. WILLIAM ASCHER & ROBERT HEALY, NATURAL RESOURCE POLICYMAKING IN DEVELOPING COUNTRIES: ENVIRONMENT, ECONOMIC GROWTH, AND INCOME DISTRIBUTION 172 (1990).

7. See generally U.S. WATER RES. COUNCIL, ECONOMIC AND ENVIRONMENTAL PRINCIPLES AND GUIDELINES FOR WATER AND RELATED LAND RESOURCES IMPLEMENTATION STUDIES (1983).

As shown in Figure 1,⁸ the *Principles and Guidelines* prescribes a six-step process for future project planning:

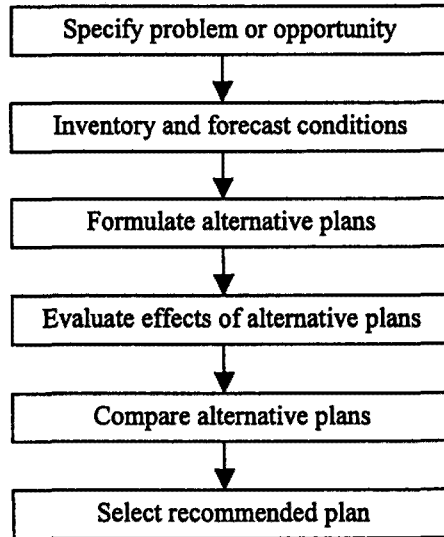


Figure 1: *Principles and Guidelines* Six-Step Planning Process

This six-step planning procedure ends with the selection of a preferred project alternative. This planning process is dynamic and allows for iterations within the six planning steps. But there is no mechanism in this framework for post-project analysis, nor does it formally incorporate project outcomes into future operations. The *P&G* framework illustrates the contrast between, on the one hand, extensive guidelines for federal water project ex ante planning, and on the other, no similar detailed guidance for ex post project evaluation.

III. FROM EVENT TO PROCESS

The six-step procedure defined in the *P&G* envisions a water resources project as an event that concludes a linear process: the procedure ends with the selection of a project alternative. Subsequent project operations are often conducted without formal guidelines for environmental monitoring and comprehensive project evaluation.

The field of policy sciences offers some alternative perspectives on water resources project evaluation. The roots of policy sciences can be

8. *Id.* at 2.

traced to the work and teachings of Charles Merriam at the University of Chicago in the 1920s. A milestone in the field was the 1950 publication of *Policy Sciences* by Harold Lasswell, who developed the following policy analysis framework, as modified below by Brewer and deLeon⁹:

1. Initiation
2. Estimation
3. Selection
4. Implementation
5. Evaluation
6. Termination

The *P&G*'s six-step planning process corresponds to steps one through three in this policy framework (e.g. step six from the *P&G*, "select recommended plan," corresponds with step three, "selection," in the Brewer-deLeon framework), but the Brewer-deLeon policy process includes additional steps of implementation, evaluation, and termination. Recognizing water resources project management as a policy process that includes evaluation (step five) could promote ex post evaluation strategies and help incorporate lessons learned into future policy and planning. The Brewer-deLeon scheme is well known in the policy sciences field, but other policy analysis frameworks have been developed. Figure 2, for example, shows a policy model defined by Australian policy analysts.¹⁰ The cyclical nature of this policy model represents a marked contrast to the planning process prescribed in the *P&G* (Figure 1).

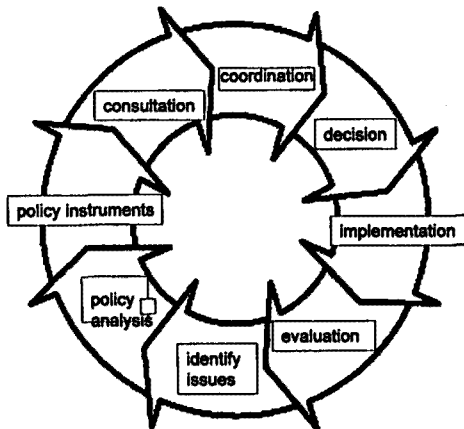


Figure 2: Policy Cycle Model

9. GERRY D. BREWER & PETER DELEON, *THE FOUNDATIONS OF POLICY ANALYSIS* 20 (1983).

10. PETER BRIDGMAN & GLYN DAVIS, *THE AUSTRALIAN POLICY HANDBOOK* 150 (2d ed., Allen & Unwin 2000) (1998).

An important step in the iterative policy cycle is evaluation. The following section describes current evaluation activities in U.S. federal water management and examines the importance of ex post evaluation for effective management, especially in light of efforts in implementing the adaptive management paradigm.

IV. EX POST EVALUATION: FRAMEWORKS, CRITERIA, INITIATIVES

Evaluation has long been an important component of social sciences inquiry. In addition to Lasswell's work in the policy sciences and Ascher's and Healy's studies,¹¹ geographer Gilbert White has advocated the use of ex post evaluations in water and environmental management programs.¹² Philosopher and educator John Dewey also emphasized the values of past experiences in addressing social problems (Dewey's studies bear some similarities to themes from Gilbert White's research¹³). There are several professional evaluation journals and the literature on evaluation in resources management is expanding.

Within the U.S. federal government, the Government Performance and Results Act (GPRA) of 1993¹⁴ requires federal agencies to submit an annual performance plan, an annual report, and a five-year strategic plan, and also emphasizes the need for methods to evaluate federal science and technological research investments. GPRA requires the reporting of agency-wide results but does not provide detailed guidance on individual project evaluation or subsequent policy change. The trend toward federal-level evaluation is also seen in the nation's river systems, where U.S. federal science and management agencies are actively involved in ecosystem monitoring. On the Upper Mississippi River, the Corps of Engineers and the Department of the Interior co-sponsor the Environmental Management Program (EMP). Since 1986, the EMP has gathered and evaluated ecological data in the Upper Mississippi basin. On the Colorado River, the Department of the Interior sponsors the Grand Canyon Monitoring and Research Program (located in Flagstaff, Arizona), which monitors changes in the Colorado River ecosystem below Glen Canyon Dam. And on the Missouri River, the Department of the Interior sponsors the Columbia (Missouri)

11. Robert G. Healy & William Ascher, *Knowledge in the Policy Process: Incorporating new environmental information in natural resources policy making*, 28 POL'Y SCI. 1 (1995).

12. See generally Gilbert F. White, *When May a Post-Audit Teach Lessons?*, in *THE FLOOD CONTROL CHALLENGE: PAST, PRESENT, AND FUTURE* (Martin Reuss & Howard Rosen eds., 1988).

13. James L. Wescoat, *Common Themes in the Work of Gilbert White and John Dewey: A Pragmatic Appraisal*, 82 ANNALS ASS'N AM. GEOGRAPHERS 587 (1992).

14. See Government Performance and Results Act of 1993, Pub. L. No. 103-62 (codified in scattered sections of 5, 31, & 39 U.S.C.).

Environmental Research Center, which assesses impacts of habitat alterations on aquatic and terrestrial ecosystems. The Department of the Interior has also proposed an ecosystem monitoring program for the Missouri River.¹⁵ These activities all point to an increasing emphasis on natural resources policy evaluation activities within the federal government and the scientific community.

A. Evaluation Criteria

There are no widely accepted ex post evaluation standards for water resources projects and programs, but there has been progress toward identifying environmental and social outcomes for inclusion in ex post analysis.¹⁶ Identifying appropriate project and program evaluation criteria constitutes several conceptual and practical challenges. A long list of project features and outcomes could be evaluated (the 1997 IUCN-World Bank reports lists roughly 100 potential water project effects¹⁷) and the criteria considered to be crucial will vary between interest groups. Many prospective criteria are qualitative and defy precise measurement and commensuration with quantified results.

In selecting evaluation criteria, the framework should be multidisciplinary and have the flexibility to add or eliminate criteria as they become more or less relevant. Given the need for flexibility, guidance on the process for selecting evaluation criteria may be more useful than identifying specific criteria to be monitored and evaluated in all circumstances. For example, a World Commission on Dams thematic review recommended that ex post evaluations should be comprehensive, integrated, long-term, cumulative, and adaptive.¹⁸

There should also be efforts to include results from ex post evaluation into subsequent policy adjustments. Adaptive management is an approach that seeks to link policy and operational changes with results from scientific evaluation.

B. Adaptive Management

The paradigm of adaptive management emerged partly in response to concerns that traditional planning approaches were not adequately

15. MO. RIVER NATURAL RESOURCES COMM. & U.S. GEOLOGICAL SURVEY, MISSOURI RIVER ENVIRONMENTAL ASSESSMENT PROGRAM 3 (n.d.).

16. INT'L UNION FOR CONSERVATION OF NATURE & NATURAL RESOURCES & WORLD BANK GROUP, LARGE DAMS: LEARNING FROM THE PAST, LOOKING AT THE FUTURE 11 (1997).

17. See generally *id.*

18. James Wescoat, Ex-Post Evaluation of Dams and Related Water Projects, Contributing Paper to the World Commission on Dams 10 (2000) (unpublished report, on file with author).

incorporating theories from research on ecosystem dynamics and the roles of disturbances, such as floods and fires. Adaptive management emphasizes the use of carefully designed experiments to obtain scientific knowledge vital to policy decisions. An adaptive management approach calls for the monitoring of management actions and seeks to incorporate new knowledge into operations and planning through a cycle of experimentation, monitoring, adaptation by organizations and stakeholders, and subsequent policy and operational changes. Through this cycle, adaptive management aims to promote resilient ecosystems and organizations.

Adaptive management seeks to determine when project and program objectives are not being met, when policies and operations should be adjusted, how they should be adjusted (both in direction and in degree), and when the next set of results are to be evaluated. Ecosystem monitoring is a crucial part of adaptive management, as ecological variables often constitute important evaluation criteria.

But the value of ecosystem monitoring will be limited if results from monitoring programs are not clearly linked to an evaluation framework and criteria. Policy science research has demonstrated that additional scientific monitoring and modeling do not necessarily improve policy decisions or environmental conditions.¹⁹ Unless it is made clear how the results from ecosystem monitoring programs are to be used in policy decisions, those programs run the risk of becoming ends in themselves, rather than a means to better resources management. Ecosystem monitoring programs should explicitly aim to inform and affect resource management decisions.

This prompts several questions surrounding the policy dimensions of adaptive management: Who decides when experiments will be conducted and what the experiments will entail? Who will decide which variables are monitored? Who will conduct the monitoring? Who will interpret the results? Who decides if objectives are being met? How will the results affect policy and operational changes? Adaptive management holds great promise and its embrace by federal science and water management agencies is encouraging. But adaptive management may entail experiments and changes that transcend the experience, legal mandates, and resources of management agencies, and may also challenge vested interests. A committee of the National Research Council (NRC) noted these realities of adaptive management: "The resilience of the politics and institutions governing the resources at stake is another important consideration. Are these governing structures likely to allow changes in resources management

19. Healy & Ascher, *supra* note 11, at 16.

in response to a new understanding of science-policy relations based on results from ecosystem monitoring and evaluation?"²⁰

Without agreement on the results from ecosystem monitoring, and agreement on how those results are to influence policy changes, adaptive management programs will be challenged to meet their full potential. One means for addressing inevitable disagreements on monitoring results and policy changes is through independent review.

C. Independent review

Even well-designed monitoring programs will be challenged by scientific uncertainties and unforeseen surprises. The inherent complexities of large ecosystems make some scientific uncertainties irreducible. Such uncertainties may be interpreted differently, thus confounding the search for appropriate policy responses. One way to address the challenges posed by scientific uncertainties is through credible, independent advice. Although participation of the operating agency increases the usefulness of ex post evaluation, "it is also essential to involve *independent scientific and technical organizations* to ensure objectivity, creativity, and credibility in evaluation."²¹ Ascher and Healy have also noted, "Inasmuch as it is a political fact of life that governmental agencies are loathe to provide negative self-evaluations, some autonomy on the part of the evaluators is essential."²²

The National Research Council's Water Science and Technology Board (WSTB) is frequently enlisted to provide independent, scientific program review of water resources programs and policies.²³ The General Accounting Office (GAO) reviews some federal water initiatives but the NRC Water Science and Technology Board has reviewed several national level policies and programs and has helped extend monitoring to management targets and corrective actions. A recent WSTB committee described the value of independent review:

20. COMM. TO REVIEW THE UPPER MISSISSIPPI RIVER-ILLINOIS WATERWAY NAVIGATION SYSTEM FEASIBILITY STUDY, NAT'L RESEARCH COUNCIL, INLAND NAVIGATION SYSTEM PLANNING: THE UPPER MISSISSIPPI RIVER-ILLINOIS WATERWAY 79 (2001).

21. Wescoat, *supra* note 18, at 10.

22. ASCHER & HEALY, *supra* note 6, at 187.

23. See COMM. ON MO. RIVER ECOSYSTEM SCIENCE, NAT'L RESEARCH COUNCIL, THE MISSOURI RIVER ECOSYSTEM: EXPLORING THE PROSPECTS FOR RECOVERY 60 (forthcoming 2002) (prepublication copy, on file with author); see generally COMM. TO REVIEW THE UPPER MISSISSIPPI RIVER-ILLINOIS WATERWAY NAVIGATION SYSTEM FEASIBILITY STUDY, NAT'L RESEARCH COUNCIL, *supra* note 20; COMM. ON GRAND CANYON MONITORING & RESEARCH, NAT'L RESEARCH COUNCIL, DOWNSTREAM: ADAPTIVE MANAGEMENT OF GLEN CANYON DAM AND THE COLORADO RIVER ECOSYSTEM (1999).

Large and important projects such as proposed lock extensions on the UMR-IWW (Upper Mississippi River-Illinois Waterway) would benefit from a second opinion. Whether the issue is surgery, revising the Head Start program, or extending locks, issues such as these are too important not to receive an independent judgment on the merits of the various approaches and a careful scrutiny of the analysis.²⁴

It is not always clear when ex post review should be conducted and there may be times when it may be inappropriate or of limited use. To help ensure a review's effectiveness, reviewers should consult with agency officials to understand the realities of agency planning and the implications of the review's results. But when an ex post review is conducted—especially in controversial projects—some degree of independence of the reviewers is essential to ensuring the evaluation's credibility.

V. SUMMARY AND CONCLUSIONS

The current setting of U.S. water resources policy features disagreements and dissatisfied stakeholders, limited coordination of federal programs and responsibilities, declining ecosystem health, and legal challenges to federal and state management agencies. Efforts by management agencies to reverse the situation are often resisted. Meanwhile, disputes fester, ecosystem health continues to decline, and many water policy disputes and problems remain unresolved.

The traditional emphasis in U.S. water resources planning and evaluation has been on potential effects of proposed projects. In contrast, formal ex post evaluation of U.S. federal water resources projects and programs has been limited. The limited amount of formal ex post evaluation of programs and projects may constitute a blind spot in U.S. water resources policy. It may be short-circuiting the policy process.

The federal *Principles and Guidelines* represents a detailed framework for the planning of future projects. No similar set of guidelines exists for evaluating the outcomes of water resources projects or programs. Water resources programs in the United States should broaden a historical emphasis on water resources projects as discrete events that conclude a linear process toward an iterative policy process that emphasizes adaptation to changing social preferences and environmental conditions. This is especially important given changing social and economic preferences and likely shifts in project purposes after implementation.

24. See COMM. TO REVIEW THE UPPER MISSISSIPPI RIVER-ILLINOIS WATERWAY NAVIGATION SYSTEM FEASIBILITY STUDY, NAT'L RESEARCH COUNCIL, *supra* note 20, at 79.

The adaptive management paradigm emphasizes an iterative evaluation process but it does not eliminate controversial policy decisions. Adaptive management is not solely based on scientific monitoring; it also includes organizational learning and adjustment to the results of evaluation. Reaching equitable and agreeable adjustments may be expensive and time consuming. Independent review of projects and programs is crucial to resolving legitimate differences and problematic science-policy issues. Independent, interdisciplinary advisory groups can be useful in devising evaluation frameworks and in conducting evaluations.

Ex post evaluation of water resources programs and projects and a broadening of the policy process represent promising steps toward slicing through U.S. water resources problems and entanglements. These proposals in themselves will not end U.S. water policy paralysis, but if implemented, they may increase the flexibility of the nation's water resources projects, policies, and organizations in adjusting to environmental and social changes.