Raindrops and Politics:
The Past and Future of Environmental Policy Analysis

Roger D. Shull
National Science Foundation

Introduction

This article is based on The Practice of Policy Analysis: Forty Years of Art & Technology (House & Shull, 1992), a recent book with objectives similar to those of this Update special issue, but focused on the broader field of public policy analysis. Main points of the book are reviewed below, with special adaptation to watershed planning and environmental management.

Forty years ago at the dawn of the computer age, water resources engineers, economists, and systems analysts worked together to assemble large mathematical simulations of the physics and economics of hypothetical command-and-control organizations and systems that would manage the quantity and quality of water flowing through watersheds in a manner that would be economically optimal for the watershed residents (Maass, et al., 1962). A few of those models and techniques have survived to be part of modern water resource planning procedures, but many others did not, principally because of their incongruity with political systems. One of the key messages of The Practice, as well as two earlier efforts (House and Shull, 1988; House and Shull, 1985), was to document, and describe from the engineers' or Federal officials' perspectives[1], some of the mismatches between theory and practice or between engineering and politics.

Watershed management, indeed, offers one of the classic examples. Executives (mostly civil engineer-hydrologists) of the Federal Water Pollution Control Administration (FWPCA)[2] often quoted a maxim something like, "A raindrop knows nothing of political boundaries." Thus, all of FWPCA's programs were implemented through nine regional offices whose territories had watershed or river basin boundaries. One of the problems created by this very natural but apolitical set of boundaries was deciding which regional office would be the research liaison with Virginia Tech (Virginia Polytechnic Institute and State University, Blacksburg, VA), a research university located immediately atop the divide between the Ohio and Middle Atlantic river basins. More serious bureaucratic problems developed with construction and enforcement programs, where many state water resources administrators were required to report to two or more FWPCA regional offices, depending on how their state borders coincided with the river basin boundaries.

In response to the hydrologists' maxim, the politicians retorted with, "Raindrops don't vote!" In other words, water resources management is the responsibility of governments or government-authorized organizations. Governments have political boundaries which only occasionally correspond with hydrologic boundaries, public revenues come from legislatures, and legislators are elected from political districts. Thus, for any government environmental program to succeed, political boundaries must be duly recognized. After a few years' experience, the FWPCA hydrologic regions were replaced with the ten state-border regions used by most Federal agencies today.

River basin management organizations with hydrologic boundaries have been created under state or Federal charters, with political representatives from each of the underlying political jurisdictions and the Federal Government. Interstate examples include the Delaware River Basin Commission, the Ohio River Valley Water Sanitation Commission, and the Great Lakes Basin Commission. While these agencies have accomplished several objectives, acquiring sufficient operating revenues from the participating states and Federal Government has always been problematical. Similar intergovernmental compacts were established at a smaller scale as "Areawide Water Quality Management" agencies under Section 208 of the 1972 Clean Water Act. Most of these agencies[3] were some amalgam of watershed and political boundaries, and required coordination of many different municipalities, counties, and sometimes multiple states. The initial plans developed by both the interstate and the areawide planning agencies were quite sophisticated, but implementation waned with the fading of Federal and local financial support in the 1980s[4].

The Metamorphosis of Environmental Policy Analysis

A simple definition of government policy analysis is the comparison of the effects of an existing or proposed set of operating rules with other options. The traditional capital project cost-benefit analysis,[5] familiar to most water resources engineers, is a type of policy analysis. The environmental impact statements required for major Federal projects (required by the National Environmental Policy Act of 1970) is another, as is the assessment of costs and benefits of new Federal regulations required by Executive Order 12291 (Reagan, 1981). Most policy analyses examine marginal changes in policies, such as the addition of an ambient quality standard for one new pollutant to the long list of established standards. But sometimes, the analysis involves a proposed quantum jump in policy. For example, in the Spring 1992 *Update*, Willey (1992) advocates shifting from our rigid procedure of fixed water pollution discharge permits and technology specifications to a system of economic incentives for pollution abatement[6]. In the brief space provided, Willey, presents the logical, legal, and ethical arguments for marketable discharge permits, along with a qualitative description of how states might switch from one system to another. But this is only the beginning of a comprehensive policy analysis. There are many quantitative environmental engineering, economic, and administrative questions that should be answered to allow state executives and legislators to decide if the benefits of the new system would be worth the significant conversion costs. Such questions, of course, can only be usefully answered by analyzing a real water resource system with real data:

✦ How much new data would be required to fairly design the new system, how much would it cost, and how would discharge allowances be related to ambient water quality?

✦ How would the system fairly accommodate all types of dischargers: industries, municipal STPs, urban runoff, agricultural runoff?

✦ What would be the basis for discharge permit fees, and how many different types of pollutants would be considered?

✦ How much self-monitoring and reporting would be required of dischargers, and how often would the state audit these procedures and records?

✦ How far up and down the stream would permit trading be permitted?

✦ What would be the anticipated response of dischargers by type: old versus new, small versus large, manufacturing versus agriculture, municipalities?

✦ Over what time period would the response be observed?

✦ What sectors or interest groups would be economically hurt and helped?

✦ What would be the anticipated water quality and changes in the state economy under the ideal scenario?

The worst-case scenario?

To help the state's citizens, executives, and legislators decide whether to gamble on the new system, state environmental policy analysts should have defensible answers to all of these questions and many more. Some can be answered with routine engineering or economic computations using existing data, but many others require new data and a deep understanding of the economics and sociology of the region. In The Practice, the evolution of public policy analysis was described in four phases, marked roughly by decades: "systems analysis" in the 1960s, "comprehensive analysis" in the 1970s, "decision models" in the 1980s, and the "personal computer era" of the 1990s. Each era saw the dominance of a different discipline or perspective in the multidisciplinary profession of policy analysis, with a slow but perceptible growth in the influence of policy analyses on the choice of new environmental management policies.

Systems Analysis

In the systems analysis era, emphasis was on method rather than matter. Analysts were eager to try out their new tools for mathematical optimization of the operational economics of water quality management. A key component in this work was the mathematical simulation of dissolved oxygen originally developed by Streeter and Phelps in 1925 (Streeter and Phelps, 1925). The most popular "problem" was to minimize the cost of achieving dissolved oxygen standards within a river basin receiving BOD discharges from several different sources of different sizes and locations. These analyses, while clever and entertaining for the analysts, never found any practical application because the real world had been distorted to fit into the model specifications. First, they used the concept of variable effluent quality among dischargers which was considered unfair by most dischargers, and second, since there was no sovereign government agency to pay for the specified wastewater treatment within the basin, the objective of overall cost minimization was politically absurd.

Comprehensive Analysis

As the lack of customers for regional optimization schemes became obvious to even the most academic of environmental systems analysts, they and their associated teams of engineers and scientists moved into the comprehensive assessments era. Comprehensive assessments were driven by the National Environmental Policy Act of 1970, that required estimating the overall environmental impact, unavoidable impacts, long- and short-term benefits, and irreversible and irretrievable commitments of resources for any major Federal project or policy, which included any action requiring a Federal license or permit. The early years of the comprehensive analysis era saw the adaptation of computer gaming and simulation models of the business administration discipline to the multidisciplinary education of environmental managers. One example of the half-dozen systems of the time was the River Basin Model (US EPA, 1972) developed for EPA. Thirty to fifty participants would gather at a facility with access to a mainframe computer, to play the roles of the major economic and political decision makers within a hypothetical river basin. Mathematical models simulated the linkages of population, land use, industrial production, economic activity, local and state laws with pollutant emissions, pollution control expenditures, and resulting environmental quality. The game was played in a series of time phases, the role-players interacting with each other and reporting their respective decisions to the computer. The computer would then report the new status of all social, economic, and environmental variables, and another period of role-playing would follow. This system was used several times around the country at various types of institutions, but did not become a commonly used educational tool because of its computational complexity and cost to implement. Also, as the environmental management profession gained experience and became more multidisciplinary, the kind of political-technical interactions that the gaming models were designed to teach became conventional wisdom.

The growing importance of national environmental quality standards and national energy planning provided an opportunity to expand comprehensive models to a national scale. The epitome of national environmental models was the Strategic Environmental Assessment System (SEAS), developed by EPA research staff (author included), assisted by several private contractors. SEAS simulated the economic activities of materials extraction, goods production, transportation, consumption, and disposal, starting with a detailed "input-output" model of the national economy that was expanded to include materials flows, pollution abatement costs, and specialized consumption demands. Scenario specifications included required pollutant reduction, associated unit pollution control costs, and materials recycling ratios. Thus, SEAS produced annual projections of the total national mass of solid, liquid, and airborne pollutants released to the environment from all point and mobile sources. These totals were then apportioned to Federal Regions, States, and SMSAs (Standard Metropolitan Statistical Areas) based on regional economic and population data. SEAS was used by EPA in 1976 to estimate total national costs of air and water pollution control and related emissions for the period 1975 to 1985 (Shull, 1979). SEAS was also used by the Department of Energy and its predecessor for conducting the environmental assessments for the first and second National Energy Plans (Mitre Corp, 1977; Assistant Secretary for Environment, 1979). Although comprehensive models like SEAS had the advantage of analyzing several policy issues simultaneously with consistent economic scenarios, they obsolesced for economic and political reasons: keeping the technical data sufficiently current and detailed for credibility to environmental experts was too expensive, and there were insufficient clients interested in the level of comprehensiveness provided.

Decision Models

The decision model era, nominally centered in the 1980s, brought back some of the earlier concepts, with a slightly greater deference to the real world than in the earlier "systems analysis" period. Decision models include procedures designed to produce the best solution to public policy issues, e.g., cost-benefit, optimization, risk analysis, and a specific subset called "decision analysis." The decision model era followed the promulgation of Executive Order 12291, that included several policies for new regulations, including "Agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefits to society, taking into account the condition of the particular industries affected by the regulations, the condition of the national economy, and other regulatory actions contemplated for the future." Federal regulatory agencies did their best to produce regulatory analyses in the spirit of E.O. 12291, but while basic economic theories were well established, specific applications were untried, and data were in short supply. A 1984 review of the state of art of benefits assessment by a panel of dozens of experts described some of the fundamental problems with using benefit calculations for public policy analysis:

> There are a number of inherent difficulties in efforts to carry out benefits assessments . . .. For instance many benefits that are intuitively felt to be most important are also among the most difficult to measure.... The choice of an appropriate discount rate for comparing benefits and costs over time is problematic. Even when benefits are quantifiable in principle and agreement can be reached on their valuation, required data may not be available.... proponents of an action may tend to assign unduly high values to those benefits which are important but hard to measure, while opponents may tend to over-emphasize the fact that the benefits which are easiest to quantify and value are relatively small... requirements imposed on [benefits assessment] can exceed our current understanding of existing practices and may well require substantial professional judgements in areas of analysis where there may be no professional consensus on the appropriate method for dealing with a specific task. (Bentkover, et al., 1984)

To increase the scientific rationality of their regulations, the Environmental Protection Agency, the Food and Drug Administration, the Occupational Safety and Health Administration, and the Consumer Product Safety Commission expanded their use of mathematical risk analysis during the 1980s. The physical, biological, and engineering science research that served this effort, indeed led to improved regulations, but we are still far from optimizing risk management through Federal regulations due to the complex web of risk-related legislation and political problems similar to those that frustrate benefits analysis. It might seem logical that the Federal Government should examine all its risk-reduction regulations, and allocate its scarce resources to those regulations and agencies where the amount of risk reduction per dollar expended is maximized. Several presidents have espoused such policies, e.g., E.O. 12291, but there is no coordinating legislation to force such coordination. Instead, there are more than a half-dozen risk-regulating agencies enforcing dozens of specific laws with hundreds of essentially independent rules. Each law and each agency has its own set of constituents, Congressional committees, and opponents. Consulting "industries" have developed whose livelihood depends on servicing the technical and legal interactions between the regulators and the regulated.

A recent report by the Carnegie Commission on Science, Technology, and Government[7] calls for extensive improvement in the coordination of all environmental and human risk-related regulations, and recommends increased communication among the executives and professional staff of all such regulatory agencies. These recommendations are not new ideas — better coordination of Federal bureau activities has been a perennial issue for well over 100 years,[8] and coordination of environmental regulations was the purpose for executive branch establishment of the Environmental Protection Agency in 1970. Strategies are proposed for implementing the changes within the existing legislative regime, including an expanded Executive Office of the President and Office of Science and Technology Policy, a rejuvenated Council on Environmental Quality, and frequent interagency technical seminars, hosted by nonprofit research institutes. The Commission makes scant mention of the increased Federal personnel costs of this coordination and the disincentives to coordination, such as interagency competition for personnel, funds, and recognition. It argues that such changes must occur, but gives no rationale for why they might be accomplished now, when so little progress has been made over the past twenty years. Perhaps the personal computer revolution is the answer.

Personal Computer Analysis

We are now deep in the "personal computer era," the technology of which has magnified the technical capabilities of policy analysts several orders of magnitude. Where projecting a single policy scenario with a given set of data would have taken weeks for several people two decades ago, several similar scenarios can now be calculated in an afternoon by a single analyst, thanks to personal computers, spreadsheet and database software, environmental simulation and pollution control cost estimation software, and large amounts of easily accessible relevant data in electronic format. Frequent electronic communication among technical staff of the major Federal science agencies (Defense, Energy, Interior, Agriculture, NIH, NOAA, NSF, EPA) and their academic colleagues is now a reality. The high-speed nationwide telecommunications networks such as Internet allow easy sharing of large scientific data bases, including numbers, graphics, and text. By eliminating the need for simultaneous presence, bypassing organizational hierarchies, and partially masking idiosyncratic personalities, combined with the inherent attraction of scientists and engineers to the technology itself, electronic mail fosters many technical exchanges that might otherwise not have occurred. This same phenomenon could be directed to coordination of the risk-regulating agencies. The agencies could be connected via network technology and provided with common data bases, document files, and status reports. With appropriate equipment, software, knowledge, and skills, even the top level coordination in the EOP and OSTP could be accomplished with but a few new or reassigned staff.

The Future

But what of environmental policy analysis in the future? Will it help our governments reach better decisions faster? Will advanced technologies lead to similar advances in the effectiveness of environmental policy analysis? Based on this author's judgement, progress will be slow. Projections of the multidimensional impacts of changes in environmental policies will be more accurate (where adequate scientific data are available), and will require fewer human resources than in the past. But governments will not necessarily reach "better" decisions, or reach decisions on tough issues faster — because we don't know what "better" means. Any change in the status quo creates winners and losers. Even where there are no obvious losers, many citizens will benefit from the change more than others. Government chief executives lament legislative gridlock, but gridlock maintains the status quo and protects the beneficiaries of current policies. Only where a specific policy change is dominantly perceived necessary by the electorate or their representatives will the government respond quickly with a "better" policy. Otherwise the present situation will remain unchanged. Perhaps the fact that our nation has survived over two hundred years under this democratic but inefficient system provides optimism for the future. As scientists, engineers, and policy analysts, we must continually strive to better understand our environment, conceive new options for more efficient management, and explain those options more clearly to our political executives. But the choice to move in a new direction must remain with the electorate. As educator-philosopher John Dewey put it,

> No government by experts in which the masses do not have the chance to inform the experts as to their needs can be anything but an oligarchy managed in the interests of the few. (Dewey, 1927)

Notes

1. Just as Q=VA is obvious to an engineer and obscure to those not schooled in the natural sciences or engineering, certain political behavior is obvious to politicians and social scientists while obscure to those of us deeply involved with the physical world.

2. The author's employer from 1968 through 1977 (incorporated into the Environmental Protection Agency in 1970).

3. Described in greater detail elsewhere in this journal by J. Heaney.

4. This is but one of the many "unfunded mandates" placed on the states by Congress, an issue of growing importance in the mid-1990s.

5. Subcommittee on Benefits and Costs, Federal Inter-Agency River Basin Committee, "Proposed Practices for the Economic Analysis of River Basin Projects," May 1950 (the "green book").

6. The author's staff at EPA was researching pollution fees as early as 1973, and Senator Muskie held hearings on the concept in May 1977, which included an 870-page reference document: Biniek, Joseph, Congressional Research Service, *Pollution Taxes, Effluent Charges, and Other Alternatives for Pollution Control*, Senate Committee on Environment and Public Works, Serial 95-5.

7. Task Force on Science and Technology in Judicial and Regulatory Decision Making, *Risk and the Environment: Improving Regulatory Decision Making*, A Report of the Carnegie Commission on Science, Technology, and Government, New York June 1993.

8. For example, "Joint Commission to Consider the Present Organization of the Signal Service, Geological Survey, Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department, with a View to Secure Greater Efficiency and Economy of Administration of the Public Service in said Bureaus," Testimony, Senate Misc. Doc 82, Serial 2345, March 16, 1886.

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Roger D. Shull is Senior Policy Analyst at the National Science Foundation. The views and opinions expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.