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Management of Environmental Quality: Observations on Recent Experience in the United States and the United Kingdom

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Introduction

Comparative analysis of experience on public policy of different countries is hazardous. This is especially true for environmental quality where public and governmental attitudes and values have been changing so rapidly. In 1960, the terms "environment" and "environmental quality" were in the lexicon of few public policy makers, except for specialists in public health. By 1965, scholars and public policymakers were using the terms as a means of organizing analysis and defining problems related to various types of pollution—air, water, and land.[1] And by 1970, environmental quality had become a major issue of national policy in this country and that of most developed nations, including Canada and Japan, as well as Eastern and Western Europe.

The views presented in this paper are the result of observations of this dynamic process at work in Europe and the United States in late 1970 and 1971—the very period when environmental quality policies and pro-

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1. Lynton K. Caldwell, "Environment: A New Focus for Public Policy?" *Public Administration Review* Vol. 23 (September 1963): pp. 132–139. Allen Kneese and Orris Herfindahl, *Quality of the Environment* (Washington, D.C.: Resources for the Future, Inc., 1965); "Restoring the Quality of Our Environment," Report of the Environmental Pollution Panel, President's Science Advisory Committee, The White House (1965).

cedures were being forged, and when the countries were working together in preparing for the U.N. Stockholm Conference on the Human Environment held in June of 1972. The results presented here are accordingly modest in scope and content. They are akin to a snapshot taken about the middle of 1971—one that shows only general outlines rather than fine-grained detail. Furthermore, it is a view that is affected by the approach of this observer, which is that of public investment analysis.

Outline of the Approach

The approach used to describe the experiences is a straight-forward version of the public investment or benefit-cost model with the important addition of an objective labeled "environmental quality," that is assumed to be distinguished from the "economic efficiency" objective.[2] In summary terms, we include a multivalued *objective function* of the usual form:

$$\max \sum_{t=1}^{T} \frac{E_t(Y_t) + \alpha Q_t(y_t) - M_t(x_t) - K_t(x_t)}{(1+r)^t},$$

where E, M, and K are economic efficiency benefits, operation, maintenance and replacement costs, and capital costs, respectively; Q is environmental quality "benefits," and α is a weighting factor that transforms Q benefits into the metric of E benefits.

Associated with the objective function are the usual relationships of costs to inputs, $M = f(x)$ and $K = f(x)$; benefit to outputs, $E = f(y)$ and $Q = f(y)$; and outputs to inputs, $y = f(x)$, which we also know as the production function.

Because contributions to environmental quality (in addition to those that can be expressed and measured in economic efficiency terms) can at best be expressed in physical, quantitative terms, and because environmental quality weights are hard to come by, and perhaps impossible

2. An earlier formulation of this approach is contained in an unpublished paper of mine entitled "Environmental Planning with Special Relation to Natural Resources," revised, Dec. 1966; further discussion is contained in my paper "Environmental Quality as a Policy & Planning Objective," *Journal of the American Institute of Planners*, Vol. 37, No. 4 (July, 1971). In order to keep the exposition simple, income redistribution, either as an objective to be achieved or as a consequence whose value is to be checked, has been omitted from the approach. In general, income distribution must be taken into account in multiple-objective public investment analysis.

to determine a priori, a more realistic formulation of the objective function for our purposes is:

$$\max \sum_{t=1}^{T} \frac{E_t(y_t) - M_t(x_t) - K_t(x_t)}{(1+r)^t},$$

subject to

$$Q_t \geqq Q_t^*,$$

as well as

$$y = f(x),$$

when Q_t^* (which along with Q_t is almost always a vector) represents a minimum level of environmental quality to be achieved in year t.

We recognize this formulation as consistent with the familiar "standards" strategy commonly used in the United States. But, in terms of the approach outlined here, the crucial issue is the weight that is implicit in the standard or set of standards in any given situation of public investment or resource allocation.

This approach is closely related to the formulations of the problem of environmental quality management by Kneese and other economists concerned with the economics of environmental quality.[3] Obviously, many of the important problems and issues of environmental economics are not made explicit in this simple formulation. Accordingly, the description and comparisons to follow will rely primarily on the barebones approach set forth above.

Overall Policies on Environmental Quality

Nineteen hundred and seventy was a watershed year for environmental policy in both the United States and Western Europe. Beginning in that year, legislation and administrative actions involving both the substance of problems and organization for problem solving were framed in terms of overall environmental quality rather than exclusively, as in the past, in terms of air pollution, water pollution, solid waste management, pesticides damages, and the like. Because this broader policy framework is so

3. A. V. Kneese and B. T. Bower, *Managing Water Quality: Economics, Technology, Institutions* (Baltimore, Johns Hopkins Press for Resources for the Future, Inc. 1968).

new, the administrative workings of government are still busy adjusting to it. It is possible, therefore, to examine the present situation with some assurance that the new policy framework will be stable at least over the next few years. Public and governmental concern for environmental quality is not a passing fad; it is gradually, but steadily, being assimilated into governmental policy and administrative practice in both the United States and Europe.

The United States

After about ten years of working up to the action incrementally, in 1970 the federal government adopted the objective of environmental quality as a major national goal on a par with economic development, employment, and price stability.

The National Environmental Policy Act (NEPA) of 1969 (signed by the President on January 1, 1970) and the newly created Environmental Protection Administration are the two chief instruments of this basic change in policy, but many other administrative, regulatory, and legal actions provide support.[4]

NEPA established the Council on Environmental Quality (CEQ) in the White House in the image of the Council of Economic Advisers. NEPA also required that an "environmental impact statement" be prepared before any federal action that significantly affects the environment is taken.[5] In a landmark decision on the Calvert Cliffs case, a Federal District Court ruled that federal agencies, in this case the Atomic Energy Commission (AEC), must comply with this requirement in a substantive way.[6] Significantly, the Executive Branch decided not to appeal this decision, and AEC changed its procedures to conform with the Court's interpretation of the law.[7]

In a parallel and related development the U.S. Water Resources Council in December 1971 formally proposed that environmental quality be included as a national objective of water resource planning, with status

4. See *Environmental Quality*, Third Annual Report of the Council on Environmental Quality, U.S.G.P.O., August 1972.

5. See Richard N. L. Andrews, "Three Fronts of Federal Environmental Policy," *Journal American Institute of Planners* Vol. 37, No. 4 (July 1971): pp. 258-266; and Richard N. L. Andrews, "Environmental Policy and Administrative Change: The National Environmental Policy Act of 1969, 1970-1971," unpublished Ph.D. dissertation. University of North Carolina, Chapel Hill, 1972.

6. Calvert Cliff's Coordinating Committee v. AEC, 449F.2d (D.C.Cir.1971).

7. AEC revised regulations (10 CFR 50, Appendix D).

equal to the objectives of national economic efficiency and regional development. Intensive public discussion of the Council's proposals over a three-month period revealed major differences of view as to appropriate levels of discount rate, and validity of the regional development objective. However, there was overwhelming approval of the environmental quality objective, and a majority of respondents on the issue expressed the view that the objective should be given top priority.[8]

Environmental quality as a major policy was also institutionalized in 1970 through the establishment of the Environmental Protection Agency via transfer of air, water quality and solid waste management functions, and pesticides and radiation regulation from existing departments and agencies.[9] Administration of the major environmental quality programs was brought together, and a powerful advocate for the environment was established.

In fact, however, the relative weight to be given environmental quality as compared with national and regional economic development in public investment decisions has not been determined by Congress, the Executive, or the Judiciary. Weights are being established implicitly in the process of making decisions on specific projects and programs, in which environmentalists and supporters of economic development along with their allies in the Congress and the administrative agencies take strongly opposing positions.

But it is clear that a series of court decisions, administrative actions, and Congressional followups since 1970 have confirmed that environmental quality is a major national goal, not to be lightly disregarded.[10] Furthermore, via the requirement for environmental impact statements, the issue of environmental quality must be faced in every public investment plan and program directly or indirectly supported by the federal government. In this sense, we can assert that, conceptually, federal public investment plans and programs have multiple-objective functions, one major element of which is environmental quality.[11]

8. U. S. Water Resources Council, *Summary Analysis*, Washington, July 1972.

9. President's Reorganization Plan No. 3 of 1970, July 9, 1970, effective December 2, 1970.

10. *Environmental Quality*, Chapters 4 and 7.

11. Only time will tell whether political commitment to environmental quality will be as strong and consistent as has been the case, for example, for economic growth and full employment during the twenty-five years following enactment of the Employment Act of 1946. But the continuing strength of public support for environmental quality values, and concomitant actions by the courts, and federal and state legislatures, support the view that environmental quality is now firmly established as a national goal.

The United Kingdom

Concern for air and water pollution is of long standing in Britain, predating that in the United States. But, as in this country, the environmental quality issue as such has emerged only recently. In October 1969, the Labour Government took the first official step concerning overall environmental quality policy by giving the newly established Secretary of State for Local Government and Regional Planning coordinating responsibilities for all governmental action on control of environmental pollution.[12] These responsibilities had previously been scattered among ten ministries. This action was followed by setting up in February, 1970, a standing Royal Commission on Environmental Pollution,[13] and in May, 1970, by issuance of a White Paper on protection of the environment.[14] The White Paper was very low key in tone and did little more than sketch the nature of problems, the current situation, and modest proposals for governmental action. Thus, when the Labour Government was turned out in the summer of 1970, only the first preliminary steps had been taken to deal with environmental quality as a major policy issue.

The environmental issue was given considerable attention by the Conservative Government in its White Paper on central government reorganization of October 15, 1970, which announced establishment of a super-Department of the Environment, unifying the Ministries of Housing and Local Government, Public Buildings and Works, and Transport under a Secretary of State for the Environment.[15] In the U. S. context this amounts to creating a super-department combining the present Departments of Housing and Urban Development, and Transportation plus the Environmental Protection Agency and the regional development functions of the Economic Development Agency and the Appalachian Regional Commission. Although the mandate of this new Department was much broader than environmental quality, the agency was charged with such major environmental matters as "the preservation of amenity, the protection of the coast and countryside, the preservation of historic towns and monuments, and the control of air, water, and noise pollution." [16]

12. *The Protection of the Environment: The Fight Against Pollution,* Cmnd 4373, H.M.S.O., May, 1970, p. 6.

13. Royal Commission on Environmental Pollution, *First Report,* Cmnd 4585, H.M.S.O., February, 1971, pp. iii, iv.

14. *The Protection of the Environment,* p. 6.

15. *The Reorganization of Central Government,* Cmnd 4506, H.M.S.O., October 15, 1970.

16. *Reorganization of Central Government,* Cmnd 4506.

Of special significance was the bringing together of land use, transport, regional development, and environmental quality programs and policy into a single organization with representation at the highest level—via a Secretary of State.

The U. K. stance with respect to environmental quality can be inferred in part from the first report of the Royal Commission on Environmental Pollution filed in February 1971.[17] An admirably well-balanced document, this report states the problem as one of how to strike a balance between "benefits gained from economic and technological achievements" and losses from "deterioration of the environment." In principle, resources devoted to reducing pollution, as compared with other claims, should depend on the relevant costs and benefits. Because of great difficulties in making such calculations, the report noted that decisions may still have to be made in the absence of satisfactory information on costs and benefits, and "in the end . . . must still reflect subjective value judgments."

In contrast to the United States action on NEPA, the U. K. organizational and policy initiatives did not, by themselves, raise environmental quality to the level of a national objective; there was no policy statement to this effect in the British enabling legislation analogous to the statement in NEPA. Yet U. K. initiative appears to give increasing importance to the objective.

In some respects, the change in U. K. policy toward environmental quality has been less striking than in the United States. British legislation and on-going programs in air and water pollution, noise and oil pollution have a much longer history than those in the United States. For example, national noise abatement legislation dates from 1960 in the U. K., and has only recently (1972) been enacted in the United States.

Thus, the change in Britain has been less in new legislation than in more active use of existing laws. Public awareness of environmental problems has increased, and various public alarms over toxic wastes—lead and cyanide—and DDT have generated a more sensitive attitude on the part of government. But, no political party in the U. K. has raised the environmental question to the level of a major issue. And, while the issue has attained considerable importance with the younger generation, it has failed to gain widespread public concern on a par with issues of economic growth, inflation, unemployment, and housing.[18]

17. Royal Commission on Environmental Pollution, *First Report*.

18. Based, in part, on personal communication from David Pearce, Department of Economics, The University of Southampton, November 30, 1972.

Although it is hazardous to generalize on this issue, it appears that the general policy stance of the British is to avoid all out commitment of national resources to grand programs of environmental improvement and to favor a careful balancing of economic and environmental costs and benefits for specific projects and restricted programs. From available evidence one could infer that environmental quality has a status that is subordinate to economic objectives. But, at least some U. K. public investments take into account the objective of environmental quality.[19]

Air Quality Programs

The United States

In the 1970 amendments to the Clean Air Act, the United States made a significant shift toward national minimum standards for both ambient air quality and emissions from stationary sources and automobiles.[20] Primary ambient air standards, based on health criteria, and secondary standards, based on "aesthetics, vegetation and materials," were established on a uniform national basis for six pollutants: particulate matter, sulfur oxides, carbon monoxide, hydrocarbons, oxides of nitrogen, and photochemical oxidants. Implementation was left to the states which must meet primary standards within three years and secondary standards within a "reasonable" time.[21] National emission standards for 1975 model automobiles require that emissions of carbon monoxide and hydrocarbons be 90 per cent below the 1970 standards and, for 1976 model cars, emissions of oxides of nitrogen be 90 per cent below 1970 levels. Emission standards for major new stationary sources, including fossil fuel steam generators, portland cement plants, sulfuric and nitric acid plants, and large incinerators, have also been established on a national basis.

The Act leaves considerable flexibility to states and local "air quality control regions," typically metropolitan areas, in determining how to

19. For example the extensive studies of the Commission on the Third London Airport (the Roskill Commission) included exhaustive examination of environmental quality aspects as well as economic costs and benefits. See Commission on the Third London Airport, *Report,* London, H.M.S.O., 1971. However, U. K. nationalized industries are not required to consider environmental effects. Also, to date, the Department of the Environment does not require that appraisals of road investments incorporate an evaluation of environmental effects. (David Pearce, November 30, 1972.)

20. Public Law 91-604 (December 31, 1970).

21. States can, if they wish, establish higher standards than those established by the EPA under provisions of the Act.

achieve the primary and secondary standards. But it has already become obvious that some large urban areas will have extreme difficulty in meeting the primary standards by 1973. EPA has already granted 2-year extensions to 18 states with such problem areas.[22] Other regions enjoy levels of air quality above the secondary standards, and a recent Federal District Court ruling enjoins the EPA from approving state implementation plans that would allow significant deterioration of existing air quality in such regions.[23]

Metropolitan areas with serious problems of meeting primary standards would have, in terms of our approach, an objective function of the following form:

$$\min \sum_{t=1}^{T} \frac{M_t(x_t) + K_t(x_t)}{(1+r)^t},$$

subject to a set of ambient air constraints on pollutants, of the form $P_i \leq P_i^*$, where P_i is the concentration per specified time period of pollutant $_i$ and P_i^* is the national standard for maximum concentration of pollutant i.

This approach to air quality management requires detailed knowledge of the cost and production functions of the various means available to state and local governments for reducing pollution at its sources and controlling its spatial and temporal distribution. An essential element is some means or model of relating changes in quantities and rates of pollution at the sources to changes in concentration in the general environment of the airshed. Although such air quality diffusion models are now in common use in air quality management, their predictive reliability in complex airsheds with many emission sources is not high. Also, the costs of various means of control, including fuel and process changes, emission control devices, and timing of emissions are not well understood. Thus, the task of attaining a least-cost means of achieving the national standards is a formidable one.

A more fundamental issue is raised, however, by the primary national standards for ambient air quality. They are based on health criteria which are admittedly incomplete and "somewhat controversial."[24] Inso-

22. This extension was declared invalid by the Court of Appeals of the District of Columbia on January 31, 1973. The ruling requires the States to submit implementation plans by April 15, 1973, as required by the Clean Air Act. "Natural Resources Defense Council v. EPA," *Law Week* Vol. 41; p. 2,400.

23. Sierra Club v. Ruckelshaus, 4 ERC 1205, 2 ELR 20262 (D.D.C. 1972).

24. *Environmental Quality*, Third Annual Report of Council on Environmental Quality, p. 7.

far as can be determined no specific information on the cost of achieving these standards in the most difficult problem areas was used in establishing the standards.[25] It seems reasonable to assume, however, that the implicit weight α or opportunity cost associated with meeting national standards will vary widely among communities. Within some reasonable range, ambient air quality standards should reflect both the health effects and the opportunity costs of achieving the standards; and because opportunity costs are likely to vary widely, no single set of national standards can meet this test.

In summary, the United States has adopted a strategy combining the national minimum ambient air standards approach, with strict national emission controls on major *new* sources, both stationary and mobile. In attempting to achieve national emission standards on 1975 and 1976 model automobiles and on major new industrial plants, the EPA will be forced to balance costs and technological feasibility against the levels of residual emissions to be allowed and the timing of required actions. It is assumed that both industry and the federal government will strive for least-cost means of meeting emission standards for new sources, and the government has attempted to explore the cost implications of national emission standards. But, differential local cost implications of meeting national ambient air standards were not taken into account in setting these standards; in effect the federal government is imposing implicit α's of unknown, but probably high, values on problem communities. In any event, the α's, are likely to have a wide range of values as among communities.

The United Kingdom

The British have a long experience in dealing with air pollution. National control over major industrial sources has been in effect for over 100 years.[26] Following the London smog episode of 1954, the Clean Air Act of 1956 (subsequently expanded in 1968) was directed at controlling pollution by domestic smoke; more recently there has been increasing concern about automobile pollution.

25. The Council on Environmental Quality, EPA, and the Department of Commerce sponsored a series of studies of economic impact of meeting air and water quality standards on the general economy and selected key industries most likely to be severely affected. But microeconomic studies of costs of meeting such standards in problem urban areas were not included in these analyses. See *The Economic Impact of Pollution Control*, U.S.G.P.O., March, 1972.

26. The Alkali Act of 1863; current industry legislation is embodied in the Alkali, etc. Works Regulation Act, 1906 and the Alkali, etc. Works Order, 1966.

British policy is almost exclusively directed at control of emission sources. No national or local ambient air quality standards have been adopted; nor is there any strong pressure to do so.

The historic British approach, developed in control of industrial sources by the Alkali Inspector, is labeled "best practicable means." Under this approach, the Government requires industries to install control equipment, based on the best available technology, to the extent that costs are within reach of the industrial organizations concerned.[27] "Best practicable means" is defined in the context of changing technology, the prevailing political and economic climate, and public attitudes toward pollution; in the rare case of dispute over a specific case, the meaning is interpreted by the courts. The system is quite flexible, and although there are no formal emission standards, the Alkali Inspectorate is able to adopt working emission standards or "presumptive limits" as a result of experience with different types of plants.[28] There is some evidence that working standards are being upgraded, under the influence of increased public concern for the environment.

The means to be used may include changes of fuel or production process, control at points of emission from the plant, and decisions on height of chimneys. Some consideration is given to existing pollution in the vicinity, and topography, micrometeorology, and presence of tall buildings in establishing height of chimneys.

Control of pollution from domestic smoke, whose source has been the traditional British open grate fire, is in the hands of local authorities. The Clean Air Acts of 1956 and 1968 give local authorities power to establish "smoke control areas" within which all smoke emissions are illegal. In such areas, householders and other establishments have been required to switch to use of smokeless fuels. Local authority grants to householders of 70 per cent of the cost of conversion are available.[29] Spectacular reductions in smoke emissions have been achieved in some urban areas, notably

27. As of 1970, 2,200 industrial plants, mainly electricity generation, cement, ceramics, chemical, petroleum and petro-chemical, and iron and steel, were regulated by the national Alkali Inspectorate; 30,000 other industrial premises were under control of some 1,100 local governments. *The Protection of the Environment,* p. 6.

28. World Health Organization, Regional Office for Europe, *Long Term Programme in Environmental Pollution Control in Europe: Trends and Developments in Air Pollution Control in Europe,* Copenhagen, 1971, pp. 8–9. See also U. K. Ministry of Housing and Local Government, *106th Annual Report on Alkali, etc. Works, 1969,* H.M.S.O., 1970, and U. K. Programmes Analysis Unit, *An Economic and Technical Appraisal of Air Pollution in the United Kingdom,* Chilton, Didcot, Berks, 1972.

29. Of the total cost of conversion, the central government bears 40 per cent, local government 30 per cent, and the householder, 30 per cent.

London, but some areas in the north of England have made little progress, and in 1970 the Government was considering using its powers under the 1968 Clean Air Act to compel laggard local authorities in badly polluted areas to make smoke control orders.[30]

As of 1971, Britain had not developed a national program of automobile emission control remotely comparable to that in the United States. The British attitude at that time is reflected in two quotations: "In Europe, due to the difference in climatic conditions, air pollution from petrol-engined vehicles presents a different and less acute problem (than in problem sections of the United States), and the development of a completely pollution-free car might not be the most sensible use of resources" [31] and "There is no firm evidence in Britain that the present level of pollutants (emitted by road vehicles) is a hazard to health, even in busy city streets, although smoke from diesel engines can be very offensive." [32] Britain is carefully watching experiences in the United States and countries in Western Europe and is conducting research along a number of fronts including the health effects of long-term exposure to automobile emissions.[33]

In contrast to the United States, Britain has not attempted to impose national ambient air quality standards; in terms of our model, it has not elevated the air quality objective to the level of a constraint that must be met. Expert opinion is skeptical that such minimum standards on specific pollutants can, in fact, be directly related to human health. Also, in contrast to the United States, Britain has not emphasized modelling and research on relating emissions to ambient air quality on an airshed basis. There is little or no information on the levels and national distribution of pollutants other than smoke and sulfur dioxide.[34] In terms of our model, the production functions are not used to provide information for formulating specific air pollution control measures. Major industrial-source emissions are controlled as uniformly as possible throughout the country and, except under special circumstances, the control requirements that are imposed do not vary with the amount of air pollution already existing in the area. On the other hand, the British are extremely sensitive to cost of control. The "best practicable means" approach emphasizes least-cost means of reducing harmful emissions, and stops short of levels of control at which marginal costs become exorbitant.

30. *The Protection of the Environment*, p. 9.
31. *The Protection of the Environment*, p. 11.
32. Royal Commission on Environmental Pollution, *First Report*, p. 12.
33. U. K. Programmes Analysis Unit, *Appraisal of Air Pollution*.
34. U. K. Programmes Analysis Unit, *Appraisal of Air Pollution*.

In summary, the British system emphasizes the cost functions, and places little emphasis on defining local emission—ambient air quality relationships or air quality—benefit functions. It is a national system which, through rejection of national minimum ambient air standards, avoids high α's in regional airsheds, but which makes no pretense to achievement of least-cost means of attaining specific levels of ambient air quality. The implicit national weight given to air quality, as related to economic development as conventionally measured, appears to be lower than the weight inferred from United States policy, if not performance. The British have consistently worked toward achieving air quality goals since 1956, and the weight given to the goals appears to be increasing relative to other national goals. But the British have attempted to strike a reasonable and consistent balance between reduction of emissions and the costs of doing so.

Water Quality Programs

The United States

The trend of national policy as revealed in the Federal Water Pollution Control Act of 1965 and the recently enacted 1972 Amendments is toward more uniform national standards on all streams, coupled with strict national effluent standards on point sources, based upon "best practicable" and "best available" technology.[35] The 1972 Amendments establish as a national goal that discharge of pollutants into navigable waters be eliminated by 1985. This and the generous financing provisions of the Amendments (total authorizations of $24.6 billion over the next three fiscal years) go far beyond the Administration's original recommendations.[36]

Passing over the details of the complex and changing water quality programs and policy of the United States, we can summarize the current status and trends as follows:

1. The requirements that states develop federally-acceptable stream standards and implementation plans, presumably related to existing

35. Public Law 92-500.

36. The President has recently reduced the allotment of waste treatment construction grants from $11.2 billion provided by the Act for fiscal years 1973 and 1974 to $5 billion.

and projected uses of streams, are consistent with a regional water quality management approach in which standards and means for achieving them could be developed in a benefit-cost or least-cost framework. Yet, as the Delaware Estuary example has shown, even where the least-cost means of achieving various quality levels have been developed through detailed systems analysis, the least-cost solution was rejected in favor of an "equitable apportionment" means which was significantly more costly.[37]

2. With few exceptions, there has been no serious, consistent attempt to relate point-source effluent requirements to ambient water quality. Secondary treatment is now generally regarded as a uniform requirement, and in certain problem areas, tertiary treatment of point sources is being strongly advocated. Only now is the federal government becoming aware of the possibility that complete point-source control of pollution in some basins may have only limited effects on stream quality of some important reaches, because of the dominance of pollutants arising from uncontrolled runoff.[38]

3. The trend in national legislation toward strong point-source effluent control, through federal permits, strict effluent standards, and major subsidies for construction (but not for operation) of local public treatment plants, is almost sure to lead to extremely high private and public costs, and to inability to even approach least-cost solutions. Prohibitive costs may well be avoided as the terms "best practicable means" and "best available means" are interpreted in the bargaining process between industry and regulatory agencies. But failure to relate these regulatory and subsidy measures to a regional water quality management framework, which ties all major sources of pollutants (point and nonpoint) to ambient water quality, will lead to grossly inefficient uses of national sources.

In terms of our model, current U.S. policy, at least in principle, seeks to:

$$\min \sum_{t=1}^{T} \frac{M_t x_t + K_t x_t}{(1+r)^t},$$

37. See Edwin Johnson, "A Study in the Economics of Water Quality Management," *Water Resources Research* Vol. 3, No. 2 (1967): 303 and Ralph Porges, "Regional Water Quality Standards," *Journal of the Sanitary Engineering Division,* Proceedings of the ASCE (June 1969): 427.

38. *Environmental Quality,* p. 16.

subject to meeting a set of ambient water quality standards

$$Q_i^s \geq Q_i^{s*}, \text{ and}$$

subject to meeting specific effluent standards often expressed as levels of treatment (secondary, tertiary),

$$Q_i^E \geq Q_i^{E*}.$$

The Q_i^{s*} have been set often with little regard to the cost of meeting them. The Q_i^{E*} have been set without any regard to the differential contribution to stream quality that may be involved in uniform application throughout the nation, a state, or a water quality region.

Insufficient emphasis is given to defining the production function [$y = f(x)$] between resource inputs to pollution control measures (x) and "outputs" in terms of improvements in water quality [(y) which is almost always a vector].

The 1972 Amendments do include some extremely worthwhile provisions for water quality research, planning, and management that may lead to significant improvements in the long run. For example, the EPA Administrator is authorized to conduct, and provide grants for, research on almost all aspects of pollution; problem sources, physical, economic, and social effects, and methods of management and control. Substantial grants are provided to states for comprehensive planning and development of long-range programs. Area-wide waste treatment management plans, focused primarily on large metropolitan areas, are required to be established, providing opportunities for achieving economies of scale. While these research, planning, and management provisions are likely to lead to long-term payoffs, they will have little effect on improving the efficiency of expenditure of the $18 billion of federal construction grants authorized for the three fiscal years 1973–1975.

Until recently, the United States has invested very little in water quality management in relation to the seriousness of the pollution problem. Limited resources have forced at least a modest amount of engineering type least-cost discipline, even though more systematic economic approaches to regional water quality management have been dismissed as too complex, impractical, or even as giving a "license to pollute." Now that major resources are being committed to the cleanup task, however, the need for systematic approaches is much greater; as a very minimum we need a strategy of avoiding prohibitively costly projects, and insuring

that major resources are not committed to projects that have only minor effect on water quality.

The United Kingdom

Since 1951, new discharges of industrial or sewage effluent require consent of the applicable River Authorities, and since 1961 all such discharges, including those in existence before October 1, 1951, require such consent. Although consent may be refused, the law stipulates that it "is not to be unreasonably withheld." No uniform effluent standards are imposed by law, but in practice most River Authorities have adopted the standards developed by a Royal Commission in 1912. These so-called Royal Commission standards have become the norm in British pollution control.[39]

Ambient or in-stream water quality standards are not used, and there is only a tenuous link between effluent standards and in-stream water quality objectives.

As of 1970 there was still widespread noncompliance with the consent conditions established by the River Authorities. Only about one-half of the reporting municipalities were in compliance with Royal Commission standards. Surprisingly, industrial compliance was reported to be better than that of municipalities. In the absence of specific national grants for sewage treatment, British communities (as, until recently, in the United States) placed low priority on investments in sewage treatment. Although national loans are available for these investments, the long drawn out technical review of such projects by the national ministry concerned provides another excuse for local communities to delay. In summary, the British have had only partial success after 20 years of effort in achieving compliance with effluent standards whose norm (the Royal Commission standards) are not overly stringent—perhaps equivalent to or slightly better than a good-practice secondary treatment plant in the United States.

Even with this mixed record, ambient river quality has shown some improvement over the past 15 years. A 1970 survey of conditions in England and Wales showed that, compared with 1958, the percentage of mileage of grossly polluted nontidal rivers (4.38 per cent) and of tidal rivers (11.7 per cent) had declined, while, at the other extreme, percentage of

39. *Taken for Granted: Report of the Working Party on Sewage Disposal*, U. K. Ministry of Housing and Local Government/The Welsh Office, H.M.S.O., 1970, p. 7.

mileage of unpolluted rivers (76.2 per cent) had increased. While overall gains were modest, the line had been held against deterioration.[40]

Under leadership of the National Water Resources Board, a systematic approach to planning for water resource management was undertaken for the River Trent, which in its upper and middle reaches is now grossly polluted. The objectives of the study, which was in the form of a multidisciplinary research program, were as follows:

1. "To determine the different ways in which the River Trent, its tributaries and other waters in, or which can be brought into, the Trent area may be used to satisfy the expected demands in that area, or elsewhere, for water for domestic, industrial, agricultural, and amenity use, of quality suitable for each."
2. "To evaluate the costs and benefits of each of those ways as a guide to determining the most efficient solution." [41]

The River Trent study represents the first major attempt in Britain to apply benefit-cost analysis and systems analysis techniques, including computer modeling to problems of water quantity and quality of an entire river basin. The need for more systematic analysis than that undertaken by staffs of the River Authorities was well recognized by professionals in the Water Resources Board, the Department of the Environment, and the national water research institutes. In the River Trent research studies the British were adapting United States water resource systems theory and practice, including such examples as the Delaware River Estuary Study, to their major problems of water quantity and quality, which had historically been dealt with by separate local agencies and even by separate professional and research groups.

The need for merging the planning and management of water quantity and quality led the Government in late 1971 to propose creation of ten new, multipurpose regional water authorities to replace the 29 existing river authorities.[42] The new authorities will assume all of the water conservation, water quality control, recreation, and navigation responsibilities of the existing authorities as well as the water supply and sewage disposal responsibilities previously performed by local governments, and re-

40. *Report of a River Pollution Survey in England and Wales, 1970,* Department of the Environment/The Welsh Office, H.M.S.O., London, 1971.

41. Water Resources Board, *Trent Research Program,* Interim Report, Reading, 1970.

42. "Reorganization of Water and Sewage Services, Government Proposals and Arrangements for Consultation," Department of the Environment, December 2, 1971.

sponsibilities for canals and river navigation previously discharged by the central government. In effect, these ten agencies will be comprehensive river basin management organizations with authority to develop new resources and to regulate water abstractions and emissions.

In terms of our model, British water quality management has been characterized by a concern for costs. Although effluent standards (the Royal Commission norms) have constituted the principal management strategy, in practice cost has been an important element in the design and timing of investments to meet the standards. Until recently, as in the Thames and Trent River studies, production function relationships between resource inputs in treatment plants and ambient stream quality have not been investigated in detail. In the past 20 years, only two national surveys of in-stream quality were conducted, one in 1958 and the second in 1970. As stated above, no national in-stream quality standards are imposed.

The Trent studies and the reorganization of river authorities point to probable adoption by Britain of some elements of the Kneese water quality management approach, with concern for developing relationships between effluents and in-stream quality, systematic search for least-cost means for achieving higher levels of stream quality, and possible use of charges to control effluents and finance needed investments. Emphasis on the Royal Commission effluent standards will decrease, as other management alternatives such as river purification lakes and timing of releases of effluents will receive increasing attention. Benefit measurement, especially of recreation and fisheries, will play a modest role. Most important, each river authority will have rather complete control of planning and management of water quantity and quality, subject only to broad national policy and financial constraints.

The objective function of a typical river authority will probably be of the form

$$\min \sum_{t=1}^{T} \frac{M_t x_t + K_t x_t}{(1+r)^t},$$

subject to a set of local ambient water quality standards

$$Q_i^s \geq Q_i^{s*}$$

The set of Q_i^{s*} would not be fixed a priori, but would be selected parametrically; that is, the cost implications of moving from one level of Q_i^{s*} to another would be investigated.

Perhaps a set of effluent standards, based on the Royal Commission model,

$$Q_i^E \geq Q_i^{E^*},$$

would also be present at least for a time.

Conclusion

In the United States, practice in air and water quality management has lagged far behind the developed theory of regional management on an airshed or watershed basis. Although some attention is given to regional management for achieving least-cost, or greatest net benefit solutions, U.S. policy has been moving toward adoption of uniform minimum national standards for both ambient air and water quality and for control of effluents, with inadequate regard for the cost-effectiveness of these approaches. In contrast, Britain has operated its air and water quality management programs with little concern for the theory of regional quality management, but with concentration on levels of effluent control that can be obtained at reasonable cost. Britain now appears ready to move toward the regional water quality management approach, and to supplement its reasonable cost of treatment strategy with one of finding least-cost means of meeting various levels of ambient stream standards.

One can summarize by noting that the United States is long on the theory of optimization and short on its practice; while the British, somewhat skeptical of optimization approaches that involve large investments of research and information, are more likely in the short-run to develop a reasonable application of the theory, at least in the water resource field.

COMMENT

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In this paper Professor Hufschmidt has examined the environmental management policies of the United States and the United Kingdom from the point of view of a public investment analyst and has attempted to infer something about the nature of the implied objective functions from the laws and other public documents. The paper includes some very useful descriptive material on the present shape of air and water pollution control policies in both countries. I found these descriptions and the com-

parisons of basic approaches to be very informative. But I am uneasy about those parts of the paper that include statements about the form of the objective function and the implied weights or relative values placed on economic efficiency and environmental quality. My skepticism is grounded in a doubt that the political system articulates consistent weights or values.

First I will discuss the concept of an objective function and two kinds of uses to which it can be put. Then I will outline a model of the political system and use it to interpret the political response to the environmental problem. This model and the interpretation of U.S. pollution control policy are offered as alternatives to Hufschmidt's analysis of the situation. Finally I will turn to some specific observations concerning Hufschmidt's interpretation of the National Environmental Policy Act of 1969.

Basically the role of an objective function is to reduce unlike or noncommensurable objects or states to some common measure such as dollars, utility, or social welfare. This is done through the use of weights or valuations to transform noncommensurate values into commensurate or additive values. The resulting summation is an index of the degree to which a given project or program achieves the goals embodied in or expressed by the weights.

When they are available and when certain conditions are met, we can use market prices as the weights. An objective function using market prices or market-related shadow prices is said to be based on an efficiency criterion. But for some kinds of outputs or states, such as environmental quality and income distribution, there may not be any prices or weights revealed by the market for making these outputs commensurate with other elements in the objective function. We then have what is sometimes called the "multiple objective problem." The multiple objectives referred to are those other objectives or criteria in addition to economic efficiency. The problem arises from the absence of market determined weights or values for converting the different objectives into a common rubric. The multiple objective problem is a problem of valuation.[1] Hufschmidt's paper is about the value or weight attached to environmental quality.

It is appropriate to distinguish between two kinds of analysis which make use of the concept of an objective function. The first I would characterize as *normative analysis* or policy design. One engaged in this form

1. See A. Myrick Freeman, III, "Project Design and Evaluation with Multiple Objectives," *The Analysis and Evaluation of Public Expenditures: The PPB System—A Compendium of Papers* (Washington, D.C., U. S. Government Printing Office, 1969), pp. 565–576.

of analysis takes an objective function as given or postulates it, and follows the function through to its logical conclusions. The aim is to rank or compare different projects or programs.

Of course a basic question here is where the analyst gets the objective function and what elements and weights should go into it? This has sparked a debate whether economists should use an objective function limited to economic effciency (i.e., those outputs to which prices can be attached) or whether it should include income distribution and now environmental quality as arguments.

I will not pursue this question. This is not Hufschmidt's topic. But I want to observe that this debate has induced some economists to undertake a different kind of analysis, something which I would characterize as the *positive analysis of objective functions.* By this I mean the formulation and testing of hypotheses about the elements of and weights of the objective functions actually used by policy makers.[2] Or to put it differently, this work represents an attempt to infer a revealed objective function from the observed choices or actions taken by policy makers.

The logic behind the positive analysis of objective functions is clear. If the terms at which one output (e.g., income redistribution) can be exchanged for another (e.g., efficiency) are known, that is if the marginal rate of transformation among outputs is known; if the actual position on the MRT surface chosen by policy makers is known; and if, in rough terms, rationality or consistency in public choice is assumed, then the implied marginal rate of substitution or valuation of one output in terms of the other can be readily calculated.[3] It is the assumption of rationality which is most troublesome.

I see Hufschmidt's paper as a somewhat informal kind of positive analysis of the relative weights given to environmental values and economic efficiency values as revealed by recent policy decisions. It is this aspect of the paper which is most troublesome to me. And the basis of my apprehension is the kind of political model which I believe underlies Hufschmidt's analysis.

2. See, for example, Robert H. Haveman, *Water Resources Investment and the Public Interest* (Nashville: Vanderbilt University Press. 1965); Burton Weisbrod, "Income Redistribution Effects and Benefit Cost Analysis," in Samuel B. Chase, editor. *Problems in Public Expenditure Analysis* (Washington, D.C.: The Brookings Institution, 1968); A. Myrick Freeman, III, "Income Distribution and Social Choice: A Pragmatic Approach," *Public Choice* VII (Fall 1969): 3-21; and K. Mera, "Experimental Determination of Relative Marginal Utilities," *Quarterly Journal of Economics* 83, No. 3 (August 1969).

3. See Freeman, "Income Distribution and Social Choice."

One can only impute some normative significance for policy analysis to revealed choices if the assumptions described above are satisfied. And if one wishes to pursue this line of inquiry, it is appropriate to ask, "What is your model of or theory of the political process which encourages you to assume these conditions are met?" At issue is whether Congress and the agencies have made or ever can make choices about trade-offs which are internally consistent and in accord with generally accepted value judgments or criteria.

One of the strongest advocates of this type of analysis is Arthur Maass.[4] Maass' discussions emphasize "community-oriented choices" which reflect the general interests of society as a whole. Maass argues that decision makers give different answers to questions depending on the way in which the question is framed and the environment in which the decision maker is called upon to make his choices. Also he argues that we can and should create government institutions for the "purpose of framing the question so as to elicit the *right,* or in our case, community-oriented, response." [5]

Maass' rather informal model is quite different from and at odds with the political models of Downs, McKean, Wildavsky, and Margolis. The latter are micromodels of the political process. They assume that individuals acting in the political process are utility maximizers who assess the gains and costs to themselves of the choices they make. Some of these models emphasize the fact that the gains and costs as perceived by decision-makers may be quite different from the social benefits and costs of these decisions. These models cast doubt on the likelihood that public choices will be either internally consistent over time and across programs or in conformity with generally acceptable value judgments. For example, what kind of objective function can be inferred from public policy decisions concerning the Aid to Dependent Children program, depletion allowances, and the Farm Price Support Program.

I don't propose that the question of which kind of model applies (if either) has been settled, or that much progress has been made. We need a far better understanding of the political decision-making process before we offer interpretations about the results of this process in terms of social welfare or objective functions. We also should be cautious about giving officials more advice about how to incorporate environmental quality or

4. See Arthur Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," *Quarterly Journal of Economics* 79, No. 2 (May 1966): 208–226; and Arthur Maass, "Public Investment Planning in the United States: Analysis and Critique," *Public Policy* 18, No. 2 (Winter 1970): 211–243.

5. Maass, "Public Investment Planning," pp. 236–238.

income distribution or regional development into their multiple-objective decision-making processes. Our analytical techniques are way ahead of our understanding of how these techniques are used and perhaps perverted in the political process, or even whether they will be used.

Hufschmidt does not provide us with a model of the political process to help in interpreting the policy action he studies. But I would argue that the implicit model underlying Hufschmidt's paper is more like that of Maass than those of Downs, McKean, et. al. In this section I will briefly sketch out an alternative micromodel of the political process and use it to interpret recent U.S. environmental policies with respect to air and water pollution control. This model focuses attention on both those policy makers who are responsible for setting and carrying out pollution control policies and the places in the political structure where decisions on policy are made.[6]

One of the functions of a political system is to reconcile or resolve conflicting interests. Many of these interests are economic in nature. With respect to the pollution issue, the conflict is over how much cleaning up of pollution is actually going to be done, and who is going to pay for it. An important element in understanding the politics of pollution is to see whether a given policy step resolves this conflict or attempts to obscure the conflict or postpone its effective resolution.

The political actors include the elected legislators and administrators as well as the appointed bureaucrats who are charged with carrying out or enforcing pollution control policies. Each of the political actors has a constituency, i.e., a group whose diverse views the actor must take into account when making decisions, because the constituency controls or at least affects his political future. The constituencies of the elected officials include all eligible voters; but in some cases, for example congressional committee chairmen, they include other elements as well. The constituencies of the bureaucrats include members of the legislative body, especially committee chairmen, senior bureaucrats and elected officials who control appointments and programs, and the specific groups affected by the policies or programs under the supervision of the bureaucrats.

Political actors may be thought of as maximizing a utility function which, in the case of elected officials, would depend upon electoral support. For bureaucrats, arguments in the utility function could include prestige, probability of promotion, budget and program size, and probability of moving to lucrative private employment at a later date.

6. See also A. Myrick Freeman, III and Robert H. Haveman, "Clean Rhetoric and Dirty Water," *The Public Interest* No. 28 (Summer 1972): 63–65.

If an elected official chooses a policy which takes something away from a group, he may lose the support of that group. He would be more likely to choose such a policy if the losers were small in number and/or ability to influence other elements of his support. In general political actors have incentives to find policies which hide the costs or shift the costs to less influential elements of their constituencies, to postpone decisions (every decision has a cost), and to avoid the costs of the decision by shifting the responsibility for making it to another place in the political system.

An important element of the model is the locus of the actual decision, i.e., where in the political structure the final decision which resolves the conflict and distributes the benefits and costs is actually made. In examining the locus of decision making, two criteria are relevant: accountability and accessibility. Ideally political actors should be accountable to all groups affected by their decisions; and all affected groups should have access to the locus of decision. However, such perfection does not characterize our political system. Institutional arrangements such as the congressional seniority system and loose campaign financial regulations that enable economic power to be transformed into political power undermine both accountability and accessibility. When such structural imperfections persist, political actors gain leeway to avoid those decisions likely to alienate major sources of support.

At least in part on the basis of this model, I am led to a quite different interpretation of the U.S.'s political response to the environmental problem. The principal feature of federal legislation dealing with air and water pollution is that responsibility for implementing pollution control plans is assigned to the states. Each state is required to set air and water quality standards and to develop and implement programs for attaining these standards. For the most part states have chosen the enforcement-regulation approach based on the issuance of permits to individual dischargers and backed up by case-by-case legal enforcement of detected violations.

I want to emphasize three aspects of the federal policy.

1. Federal legislators have consistently shifted the burden for making difficult decisions to the states (for example the setting of standards, or the issuing of discharge permits), or to decision makers within the federal bureaucracy (EPA).[7] Furthermore the guidelines accompanying

7. The shift away from reliance on states under a federal framework and toward federally imposed standards which are the principal features of the Clean Air Act of 1970 and the Clean Water Amendments of 1972 is not inconsistent with the model

these delegations of authority have been vague and poorly defined leaving considerable discretion to the ultimate decision makers and expanding the scope for negotiation and bargaining on a case-by-case basis. As a result, those who make the real decisions about who cleans up how much are typically both less accountable and less accessible than the legislators who pass the basic legislation. Federal legislation typically passes with large majorities, sometimes unanimously. One can only conclude—if everybody is for it they must have found some way to duck the real issue.

2. Setting environmental quality standards is a meaningless exercise unless effective mechanisms are developed for achieving the standards. Almost without exception, states have placed primary reliance on some form of licensing accompanied by judicial enforcement of the license terms. The political aspects of this procedure are quite unfavorable to effective pollution control.[8] The adoption of a licensing system does not resolve the political conflicts inherent in pollution policy. Instead, there is a continuing political conflict over license applications, terms and limits on discharges, and enforcement. Furthermore, these battles are fought on terms that are advantageous to dischargers for several reasons. The political issues are removed from the legislative arena and placed in a bureaucratic one where accountability and accessibility are less. The choices are more likely to be framed in technical terms that make it difficult to articulate the public interest. Finally, each discharger has large incentives to devote resources and energy toward swinging the decision his way; the public interest is diffuse and because few people have the incentive or the command of resources, likely to be poorly represented.

3. Policy-makers have been willing to subsidize industrial dischargers wherever this could be hidden in tax-depreciation formulae or municipal cost-sharing programs.

In sum, the political system has responded to the emerging environmental problem by shifting the real decisions from the federal to the state

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sketched out here. This shift can be viewed as a rational political response to public pressure to do something, or at least to give the appearance of doing something. And furthermore, it is not at all clear that this greater federal involvement represents a movement toward more effective policy. In fact developments as of early February 1973 suggest an imminent breakdown of the implementation of air quality programs in major urban areas such as New York City and Los Angeles.

8. See A. Myrick Freeman, III and Robert H. Haveman, "Residuals Charges for Pollution Control: A Policy Evaluation," *Science* 177, No. 4046 (July 1972): esp. 328–329.

level and from legislatures to bureaucratic agencies. It has tended to make decisions in arenas where there is less accountability and accessibility, and to avoid final resolutions of the political conflicts in favor of piecemeal, fragmented decisions. All of these tendencies work against the public interest in pollution control.

Now let me offer some comments on the inferences drawn by Hufschmidt concerning the National Environmental Policy Act (NEPA) of 1969. Hufschmidt interprets NEPA as raising environmental quality to the level of a national objective in a multiple-objective function. In a narrow formal sense this is true, because it is the stated purpose of the Act itself. But when the Act and the subsequent actions of governmental agencies are examined from the perspective of the political model previously outlined, it is not clear that there was any change in federal policy in an operational sense.

First, although Congress said that environmental values must also be weighted in the decision process, it placed the responsibility for weighing these factors and making the actual decisions in the hands of the executive branch.

Second, Congress gave no guidance as to what kind of analytical framework should be used or what weight should be placed on environmental considerations relative to other values in the decision process. The exact language reads, "Will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations." But what meaning can be given to "appropriate" in this context?

Finally the agencies to whom the Act is directed have responded in most part only in a pro forma way. In general the agencies have taken steps to meet the technical requirements of the Act, i.e., the drafting of impact statements, but even this has required the prodding of the courts. But it is difficult to find examples of agencies voluntarily making decisions which are different than they would have been in the absence of the Act. Rather there is some justification for the charge that impact statements have become vehicles for justifying or rationalizing politically predetermined decisions (the Alaskan pipeline is a case in point). In fact one could argue that the agencies, having been handed a hot potato by Congress, have deftly passed it on to the federal judiciary. Whatever impact NEPA has had on decision making and environmental policy has come about through court orders and injunctions rather than through prompt and bold agency response to a clear statement of national policy objectives.