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Project Summary

Case Studies in the Application of Air Quality Modeling in Environmental Decision Making

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Eleven case studies of the application of air quality models were undertaken in order to examine the problems encountered when trying to use these models in making environmental policy decisions. The case studies of air pollution control decisions describe the decision process, the models used, the critiques of the models, and the participation by outside interest groups in the decision process. The studies include two cases of federal decisions, seven state decisions, one local decision, and a review of the evolution of modeling requirements in the Clean Air legislation. The time covered is from 1970 to the present and includes several cases for which a final decision has not yet been made.

The results of this investigation show that indeed the well-known technical and political constraints exist but that unresolved policy issues, the management of the decision process and conflicting institutional and organizational interests also cause problems. Recommendations are made on how to improve the technical planning and management of the decision process so that the air quality models can become a better policy tool within the state-of-the-art, political and organizational constraints.

This Project Summary was developed by EPA's Environmental Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Clean Air Act provides for the establishment of the ambient air quality standards for ubiquitous air pollutants arising from multiple sources. The strategy of the legislation for achieving these standards is emissions and land-use controls. The jurisdiction for establishing these controls is shared between the U.S. Environmental Protection Agency (EPA) and various state and local government agencies. This legislative framework, then, provides for the application of air quality models, mathematical models which relate the emissions of pollution sources to the pollutant concentrations in the ambient air, as an aid in establishing the emissions and land-use related controls.

This research project consists of eleven case studies of specific applications of air quality models by EPA and state and local agencies. It grew out of the concern that, although the legislation and EPA regulations seem to call for the use of air quality models in making environmental control decisions, many modelers as well as potential users of models are dissatisfied: the modelers because they are not listened to and the users because they do not hear much that they want to listen to. Also, the users may apply the models in ways other than those intended by the modelers. Thus, the case studies examine this conflict between modelers and decision makers (users). The focus is on the decision process and what role the technical information produced by the models plays within that process.

The studies reveal the problems that arise in using research tools as policy tools. In making environmental policy decisions EPA and the state and local agencies require a sound scientific basis. Scientific research, including air quality models, has become increasingly important as well as more sophisticated and widespread. However, as a useful input to the decision making process, the research has in many cases not met expectations. One problem often pointed out is the state-of-the-art of environmental research; such research has not yet reached the level of maturity where it can supply information in the detail and accuracy required by policy problems. Gaps certainly do exist in the available information. However, the reasons why these gaps exist and why the flow of information between researchers and decision makers is so difficult can also be traced to the different professional and organizational settings within which researchers and decision makers work. Thus, the case studies describe the decision process, what role the models played within this political context and how the modelers, given their professional and organizational orientation, did or did not respond to the policy dimensions of the problem. Except to outline the implications of the parameters and assumptions chosen for each model analysis, and the controversies surrounding these choices, no technical critique of the models themselves is made. Instead the case studies focus on the uses of the models within the decision process.

The details of the case studies show that the controversies and delays arise not only from the model formulations and capabilities but also from the process as laid down in the legislation and as managed by EPA and the states. These factors together cause a narrow and sometimes contradictory definition of both the problem to be resolved and the solution proposed. No one factor stands out as the dominant cause or easy target for reform. Solutions appear to be as complex as the problem.

The Case Studies

The case studies were picked from the point of view of illustrating different levels of decision making (national to local), different institutional domains (legislative, administrative and judicial) as well as the different EPA programs which require air quality modeling analyses.

Clean Air Legislation

The overall strategy of the Clean Air Act is one of technology-forcing, requiring technical fixes which the experts do not necessarily agree are available. This strategy was inaugurated in 1970 when the Congress concluded that if they waited until the technology was available and control was demonstrated to be economically feasible, it would never happen. Thus, they constructed a system of national ambient standards based on health effects but not cost considerations. Such a system depends, in part, on having air quality models to predict the relationship between source emissions and ambient quality.

In 1977 the Clean Air Act was amended to include modeling requirements in three of its provisions: prevention of significant deterioration (PSD), visibility protection, and nonattainment. During the legislative debate on these amendments the accuracy and predictive capabilities of the models was discussed but generally ignored, because no alternatives were proposed. The general agreement was that models should be only one policy-making tool but little attention was given to what other tools might be available. Instead attention was focused on the political questions of how to strike the balance between protection of health and economic feasibility. To the extent that EPA might be tempted too far to the economic side, the modeling requirement was inserted to focus efforts on the standards.

The technology-forcing philosophy and standard-setting strategy of the act reinforced the tendency not to investigate too deeply whether models to suit the new programs were available. If the health-based standards require a given level of control, then technology to achieve that level will have to be developed. Similarly if the strategy of standards implies the use of modeling, then models will be required.

Thus, the legislators naturally debated the political questions, leaving the implementation question to the administrators. They have legitimized the use of the air quality models while not actually having applied the models or made decisions requiring the use of the models. As the other case studies show, the Clean Air Act modeling provisions have been interpreted as requiring modeling in almost every case and have occasioned much controversy and delay generated by special interests (both industry and environmentalists), situations possibly not envisioned by the legislators.

MATEP

In 1977 Harvard University applied to the state of Massachusetts for an air quality permit to construct a cogeneration power plant (the MATEP power plant) to be built near downtown Boston to serve a hospital complex. As designed, the new plant would emit fewer pollutants than the plant it replaced and would meet all existing ambient standards. Prior to 1977, several citizens' groups had been battling Harvard's expansion of the hospital facilities into their residential neighborhood. The proposed new construction served as another rallying point for their opposition, and their goal became to stop the plant rather than to search for alternative sites or design configurations. Their tactics did focus, however, on the scientific evidence and environmental standards as well as legal maneuvers to delay construction and influence the permit decision.

The state's modelers, meanwhile, focused on the federal standards. This turned out to be too narrow a perspective both politically and technically. Politically, the citizens' groups raised the problem of short-term nitrogen dioxide levels for which there is no federal standard. Technically, without readily available models to analyze the possibility of an ozone limitation to the formation of nitrogen dioxide and the problem of variability in diesel emissions at start-up the state analysts tended to ignore these problems. Such issues were brought up in the public hearings, causing a delay while the problem was analyzed, and left the decision maker faced with many uncertainties subject to heated debate but no resolution.

Pittston

The Pittston company has applied for a permit to build an oil refinery in a rural community in northern Maine near the Canadian border and a national park. The company redesigned the project several times to reduce emissions so as to meet the stringent PSD standards.

They were opposed by citizens of the surrounding community who felt their livelihood (fishing) was threatened, as well as some influential U.S. Congressmen who had passed the PSD amendment to ensure that national parks retain their clean air. The EPA regional office reviewed the company's analyses and conducted their own in an effort to obtain a suitable project design. However, they did not look for alternative sites for such a project because that issue had been settled before on economic grounds and EPA was committed to supporting that decision.

With the pressure to reach an agreement on the project discussions with the regional administrator, the decision maker, was limited to the question of when, not whether, the permit should be issued. Little discussion of the accuracy of the models or what environmental impacts may not have been measured took place. This was in part also due to technical issues. Although the PSD standards are easier to violate and demand more precise measurement, they appear to be of the same type as the other EPA standards. Because the decision maker was not familiar enough with the air quality models to make this distinction, he had to rely on the analysts. But the analysts did not raise this issue because they did not have other methods to draw on. In the end the citizens' groups seemed to have only a limited impact on the decision making process. They were geographically separated from the EPA regional office in Boston and did not have access to modeling resources of their own. Many of the technical issues they did raise were not resolved within the time frame EPA had set for the decision.

Anaconda

EPA's first proposal for an emissions standard for the copper smelter located in Anaconda, Montana was dismissed in court as an arbitrary figure which EPA had intended not as defendable but as bait for further discussion. Also, nonferrous copper smelters were singled out in the Clean Air Act as sources particularly difficult to control and, hence, potentially able to be granted exemptions from complying with standards. These two factors provided EPA with the incentive it needed to commit vast resources to modeling this copper smelter. They used a helicopter to collect data and developed a model to be used in complex mountainous terrain.

It took over seven years to reach agreement on an emissions limitation. In general the state supported the company, the largest employer in its state. It was not until a new governor was elected and the company was bought by the Atlantic Richfield Company that a compliance schedule was agreed upon. Thus, the agreement was due as much to the change of governor and company management as it was to the extensive monitoring and validation efforts of EPA. Nine months after the agreement was signed and following a lengthy, unsettled labor strike, however, the company closed the plant citing environmental, health and safety reasons as the cause.

Westvaco

The Westvaco pulp and paper mill is located in rural Maryland. In this case the company collected monitoring data and submitted modeling analyses to the EPA regional office. The state again supported a large employer within their state. EPA did not have the resources to do modeling of its own so it criticized the company's analysis, pointing out that the company's monitors were not sited where standard violations were expected to occur and suggesting several changes in the technical analyses. The company responded by submitting more data from its misplaced monitors, building a taller stack which would tend to disperse rather than reduce the total amount of pollution, and appealing to influential U.S. Congressmen for support. There was very little communication between the parties except on the narrow technical issues. Also, on several issues, including the siting of monitors on private property and whether a taller stack could or could not be used as a dispersion technique, the EPA Headquarters office responsible for setting national policy was silent. Thus, Westvaco had no incentive to upgrade either its data or its analysis and a deadlock ensued.

Massachusetts' Sulfur Regulations

Until the 1973 oil crisis Massachusetts' regulation restricting the sulfur content in fuel that could be burned by electric utilities was determined by the availability of low sulfur fuel. But, as the price began to rise, the state legislature demanded a technical justification for these regulations based on the impacts on ambient air quality. Several interested parties (the utilities, the state and EPA) initiated modeling analyses. These analyses differed according to how each party formulated the question to be answered by the model based on their own perspective. There was very little effort made to coordinate these analyses. In the end, the state based their decision on their model, in part because no violations of the federal standards were being monitored and in part because EPA agreed that the analysis was acceptable given the limited time and resources.

Ohio's State Implementation Plan

Ohio was the last large industrial state to propose a State Implementation Plan and could not agree on a control plan for two large power plants located near Lake Erie and owned by the Cleveland Electric Illuminating Company (CEI). Thus, EPA was left to negotiate with CEI. They both did modeling analyses based on data collected by CEI from a monitoring network which EPA criticized as inadequate. Meanwhile, the company also sought help from Congress and the White House. This aid came in the form of a memorandum from the Council on Wage and Price Stability which effectively eliminated several control options (installation of scrubbers and use of low sulfur coal) leaving only the noncompliance option. The question of tall stacks, long-range transport and acid rain was not addressed because the discussion of issues, as directed by EPA, was never expanded beyond the narrow local impacts that the available air quality models addressed while the spectre of economic hardship (without technical analysis of the issue) won the day.

Connecticut's Transportation Control Plan

The state of Connecticut felt that their oxidant problem was due to transport of emissions downwind from sources located in New York and New Jersey. The national policy of EPA was, however, that each state was responsible for the pollution that was monitored within its own borders and their models did not take the transport factor into account. The state environmental agency attempted to develop its own model but ran into opposition from several quarters including EPA. The state department of transportation opposed the model because it did not like the results which indicated that many highway projects would be rejected. The legislature and the governor would not support any plan requiring controls until EPA acted to make the other state implement controls. When concessions were made to try to draw up an acceptable plan, the environmentalists opposed the changes. To remove one obstacle the state abandoned their model for an EPA approved model. However, EPA had been threatening sanctions if the state did not come up with an acceptable transportation control plan but never carried out their threats. Thus, the legislature felt free to order another study and ensure that nothing was done "prematurely," before other states in the region.

The San Francisco Air Quality Maintenance Plan

In 1975 the Association of Bay Area Governments (ABAG) was awarded a federal grant to develop an integrated air quality, water quality and solid waste management plan. It was the first grant of its kind and set the stage for a sophisticated and elaborate modeling analysis. ABAG was also fortunate in having a private institution (the Lawrence Livermore Laboratory) who raised funds from outside sources to develop an air quality model specific to the regions and useable by the agency. The process followed by ABAG in developing the integrated Environmental Management Plan was the one they had traditionally used for other of the region's governmental programs. It included the formation of task forces at both the managerial and technical staff level with a broad representation of interests. The task forces were formed at the beginning of the process and given the responsibility of negotiating an overall solution or agreement on the facts. The primary aim of such a process was public acceptability of the technical data. It effectively removed the ability of any one agency to exercise a veto over the plan.

The goals were limited. They included improvement in air quality by the greatest possible amount and compliance with standards at the earliest possible date but subject to the condition that the plan be implementable. This meant that some measures, while capable of achieving immediate compliance with certain standards, were rejected as politically unacceptable or were relegated to further discussion. But the relative success of this process meant a concensus was reached among the technical experts that the best possible job had been done. This in turn established technical credibility in the eyes of the public, an important step in establishing political legitimacy for the plan.

Ozone Standard Revision

When the question of whether or not the national ambient air quality standard for ozone ought to be revised arose, the EPA Office of Research and Development set up several task forces of scientists to review both the health data and the air quality models. The controversy surrounding the standard revision decision focused on the review of the health data since these data would be the basis for the decision. The review of the models' capabilities was relatively non-controversial because the models would only be used later in implementing the standard and because the results of the review suggested that the most flexible of approaches to the use of models should replace the existing regulation which required the use of a linear rollback type model.

Although the Clean Air Act requires an ambient standard to be based on health effects alone, a Presidential Executive Order requires the compilation of the estimated costs of regulatory actions. EPA's analysis of cost impacts of the proposed standard included the use of air quality models. At first a newly developed model was used but as attention was focused on the results, the high cost of the standard, the linear rollback model was substituted. It tended to give lower cost estimates. The justification for the change was that city specific data needed for the original model were not available and that nationwide reduction estimates did not require a high degree of accuracy. Thus, while the choice of model may have been correct for the problem as defined by EPA, the choice was simplified by political considerations.

New Source Performance Standards

In revising the new source performance standards for coal-fired power plants EPA made a concerted effort to develop a set of technical facts that the various sides could agree on and which could be used to defend the standard. That they were successful for the most part can be attributed to the early commitment by the top management of both EPA and the U.S. Department of Energy of not only time and resources but also a commitment to a cooperative task force arrangement for the actual development of the technical information. They were able to use a model of sufficient complexity and flexibility for the situation that was available and did not have to be developed. EPA solicited public participation by both the utilities and environmentalists from the beginning of the process and demonstrated their willingness to change their analyses in response to the public criticisms. Thus, the conscious management of the process helped EPA achieve its main aim, to resolve as many technical issues as possible so as to focus the political debate on the political issues—whether costs or emissions are more important—rather than the technical issues—what will the costs or emissions be.

Conclusions

The problems encountered in these case studies were generally of four kinds

- —technical and political constraints,
- —unresolved policy issues,
- —management by EPA of the decision process, and
- —conflicting institutional and organizational interests.

The major technical problems included a lack of verification studies for complex topographic situations, lack of input monitoring data, lack of sensitivity analysis and output formats that did not take into account the broader question of how air pollution control fits into the energy and employment problems. The political constraints included the energy and employment impacts of EPA's decisions but also the interests and intervention of outside parties such as industry and environmentalists. The intervention by other parties became an issue in those cases where the lobbying activities came toward the end of the modeling process and delayed the process while the modeler defended the technical analysis. In those instances when outside parties were encouraged to participate from the beginning of the process the technical analysis was changed and improved in response to the lobbyists concerns.

The policy problem centered on a lack of directives from the federal EPA on interregional policy issues. Thus, we saw that often the primary question being debated was what assumptions as to wind speed or worst case meteorology to use for the model already chosen. The question of where to site monitors to provide input data or which model to use or whether any model can adequately address the transport problem was secondary and often never addressed. The answers to these questions are technically harder but also, because of their national implications, often beyond the jurisdiction of the state or local agency overseeing the modeling. The focus remained on the technical problems of the particular model with no mechanism to force a policy decision by the federal EPA.

Several aspects of the management of the decision process led to an isolation of the technical analysis in the early stages of the process and a lack of legitimacy or credibility for the analysis. No systematic effort at choosing the most appropriate model was made or, at a minimum, was made clear to the public. Thus, the choice was not established as the best, given the state-of-the-art and resource constraints. The modeling analysis was then done or critiqued by EPA but the early isolation left the modeler in a defensive posture, providing justification for the resources already spent, but lacking the resources or the desire to make changes. This lack of discussion of alternatives in turn led to a lack of credibility for the analysis. Those cases where public participation occurred before the model results were known were much more successful in getting technical issues resolved and the debate focused on the political issues.

In each case study different institutions and organizations had separate and conflicting interests in the impact of the decisions. The clearest example is the opposing interests of industry and environmental interest groups. However, within EPA the headquarters offices often have a different perspective than the regional offices. Also, EPA and the states differ on problems, such as transport, which impact differently on the local and national levels. The consequence of these conflicting interests may be delay while they are heard although, again, a successful management of the process will use these interests to produce additional information and improved analyses.

Not all of these factors will be under the control of the decision maker or the modeler. The recommendations of this report focus on those that can be controlled or changed (mainly the technical and managerial ones). They recognize and try to work within the others as limitations or constraints on the decision process.

Recommendations

The recommendations focus on what steps can be taken to make the available technical information, given the state-of-the-art of air quality modeling and the current legislative framework, more useful to the decision maker. Thus, they focus on technical planning and management changes and require new cooperative efforts which recognize organizational and institutional conflicts.

1. *Plan and require monitoring.*

Many of the ultimate decisions were to require a better monitoring network, but these decisions were made after a delay of several years and controversial court cases. Instead an appropriate monitoring system should be required as the first step in the decision process.

2. *Detail guidelines for sensitivity analysis and output format when developing a model.*

The inclusion of these activities in model development rather than model application will make sensitivity analyses easier and the model output more flexible but, more importantly, it will force the modeler to develop a model which is more likely to be relevant to the policy (as opposed to research) setting.

3. *Focus verification studies on actual needs.*

EPA's programs to verify models should be based on problems discovered through past applications of the models and what problems the users expect they will be called upon to address.

4. *Include all interested parties from the beginning.*

This could be done through early fact-finding public hearings or the formation of task forces. It appears to require extra resources and time but the case studies show that decisions take years and, more importantly, that it is ccstly and time consuming to have an issue raised late in the process when the issue could and should have been dealt with earlier.

5. *Establish criteria and boundaries for the technical analysis for each decision.*

If such questions as what are the broader issues, what is the range of policy issues, and if modeling should be done at all are asked before choosing which model, which data or which assumptions, it is more likely that the decision will not founder on technical questions but instead can be focused on the policy issues.

6. *Establish agreement on state-of-the-art and assumptions before the technical results are presented.*

Early in the process the discussion should focus on what is the appropriate model given the available resources. In this way it is harder to choose a model because of what results it gives rather than because it is the right model for the situation. How to negotiate such agreements will come through experience as there are few examples of such attempts, much less successful outcomes.

7. *Establish joint industry/EPA modeling studies.*

This could help force agreement early on the technical assumptions. Other interests should also be included but the major resources would be from industry and EPA.

8. *Explain decision and alternatives considered in detail.*

To establish legitimacy for the process the basis for the decision has to be made public. This also encourages the broader consideration of alternatives during the decision process.

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The complete report, entitled "Case Studies in the Application of Air Quality Modeling in Environmental Decision Making," (Order No. PB 81-213 233; Cost: $9.50, subject to change) will be available only from:
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