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Project Summary

Socioeconomic Analysis of Hazardous Waste Management Alternatives: Methodology and Demonstration

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A method to analyze the economic and social effects of alternative approaches to hazardous waste management has been developed. The techniques of economic analysis used for conventional pollutants are not always appropriate or feasible for hazardous wastes. Thus, a new approach is desirable—one involving (1) generating a series of environmental threat scenarios that might arise from the use of various hazardous waste management techniques and (2) identifying parties-at-interest to these techniques. By examining how parties-at-interest are affected by alternative approaches to hazardous waste management, economic decisions recognizing sociological factors can be made.

This approach, applied in a generalized manner to various hazardous waste management techniques, is demonstrated in two management decision situations. One example analyzes alternative techniques that could be applied to a single waste stream; the second is a case study of alternative approaches to hazardous waste management for Oregon. These cases demonstrate that though the decisionmaker's task is simplified, the ultimate decision depends on the degree of risk aversion favored and may involve subjective elements.

The report provides references to extensive data on various hazardous waste management techniques and their associated risks. The appendices include methods to evaluate the various effects (such as environmental impacts) of waste management techniques on public attitudes toward environmental issues and on methods to handle effects that extend over a long period. Appendix E includes a pragmatic solution to the problem of intergenerational discounting. Research on risk-taking and its relationship to decisionmaking is reviewed in Appendix F.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, 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

Methodology was developed and demonstrated to analyze hazardous waste management problems based on economics but cognizant of societal concerns and public attitudes. The

methodology is designed to identify costs and effects associated with alternative approaches to hazardous waste management. A decisionmaker is encouraged to consider the attitudes of concerned parties-at-interest while assessing trade-offs among alternatives. Since the effects of certain hazardous waste disposal practices are often ill-defined or virtually unknown, a decisionmaker is encouraged to identify possible environmental threats and to evaluate the costs of different degrees of risk aversion.

Although this report specifically excludes radioactive wastes, the general approach could be applied to any category of wastes, including radioactive wastes.

Overview of Hazardous Waste Management

From the economist's viewpoint, the management of hazardous wastes has certain features that differentiates it from the management of other wastes or pollutants. Since the potential damage from hazardous wastes poses far greater threats to man and the environment than nonhazardous wastes, the economist or decisionmaker is largely concerned with threats or risks rather than with predictable environmental impacts. Specific threats are particularly difficult to define since some wastes are biologically magnified or have cumulative effects on organisms. Hazardous waste reactions are difficult to predict since waste containing multiple components can exhibit antagonistic and synergistic effects. Many hazardous wastes are nondegradable or persistent in the environment and their environmental effects may thus be irreversible. Because of the magnitude of the threats posed, techniques must generally be implemented to minimize environmental exposure, and management techniques may be needed for perpetual care of these wastes.

Because of these special characteristics of hazardous wastes, traditional approaches to the economic analysis of pollution control will often be inappropriate, and comprehensive cost-benefit or risk-benefit studies may be neither feasible nor warranted.

General Methodology for Analysis of Hazardous Waste Management Alternatives

The primary objective of the methodology is to provide a "framework for analysis" of hazardous waste alternatives that is comparatively simple to apply and that has modest data requirements. This analysis does not attempt to determine an optimum solution. Choices among alternatives ultimately remain the perogative of the decisionmaker who can make reasonable trade-offs and introduce whatever degree of risk aversion deemed necessary.

The methodology involves three phases as follows: (1) obtaining prerequisite information, (2) applying the analytical framework, and (3) decisionmaking.

Prerequisite Information for Analysis

Obtaining prerequisite information consists of four steps. First, define the scope of the study including the geographic extent of the managing organization's jurisdiction and the waste types included in that area. Geographic extent is usually dictated by the study's terms of reference and is likely to correspond to a political division or unit. Two aspects of waste type are considered—the source-related categories of waste and a method to determine which wastes are considered hazardous.

The second step is to obtain a general overview of the existing hazardous waste situation based on the precise objectives of the study. In most cases, information on the sources, types, quantities, and current disposition of wastes would be appropriate. The existing waste management approach will make a useful reference that may be compared with possible changes resulting from the new approaches that will be analyzed.

The third step is to determine direct and indirect controls placed on hazardous wastes. Explicit controls may take the form of mandating the ultimate disposal of certain wastes in chemical landfills, whereas the Clean Air Act Amendments of 1970 and the Federal Water Pollution Control Act Amendments of 1972 are examples of indirect controls.

The final prerequisite is to ascertain the policy objectives that will govern the approaches to control hazardous wastes. Since policy objectives generally deal with normative issues, the choice among approaches may require trade-offs between achievement of different objectives.

Analytical Framework

Applying the analytical framework requires eight sequential steps:

1. Develop alternative approaches to the current means of hazardous waste management. Each approach represents an alternative general philosophy or strategy that should be broadly consistent with policy objectives. Actions may be directed towards a favorable solution or away from an unfavorable result through mandates and incentives.

2. Determine which waste management techniques might be used to control specific wastes. Each approach developed in the first step will have a different effect on the technique chosen.

3. Develop threat scenarios for each technique from modeling studies or past experience, public fears, or assumptions. Each scenario, developed from simple quantitative data, is a hypothetical chain of events leading to an adverse environmental impact. More detailed data may be appropriate after the number of approaches has been narrowed down. Also list environmental impacts relating to energy and resource use.

4. Determine the economic and social effects of each technique, which gives rise to control costs, environmental costs, and social impacts. Control costs include: costs incurred by generators for treatment, transport, disposal, research, etc.; costs incurred by governing bodies for administration and enforcement; and social control costs such as government subsidies. Environmental (damage) costs arise from the threat of physical environmental degradation; included are damage to human life and health, and damage or destruction of natural ecosystems—plant and animal life. Social impacts involve aesthetic factors and option values and will more frequently defy quantification in dollar terms. Effects are evaluated for each of the techniques involved in any approach being considered.

5. Predict the reactions of parties-at-interest or those groups that are affected in a common manner by the techniques under consideration within alternative approaches. Positive, negative, or indifferent reactions are assigned to each waste management technique for each interest group.

6. Project responses from the reactions of interest groups. Responses may range from a generator's raising prices to cover increased waste management costs to public protest of potential adverse effects.

7. Predict the physical outcomes of the individual waste management techniques under each approach. Physical outcomes include waste dispositions, which are usually determined by the initial allocation of wastes to techniques, and the responses of the parties-at-interest. At this stage, it is also appropriate to consider how the quantities of wastes will change in the future, although the quantities of wastes requiring disposal may not change at the same rate because of in-plant treatment, volume reduction, or resource recovery. Environmental threats may be listed as outcomes even though only those that materialize constitute actual physical outcomes.

8. List all the costs associated with particular management approaches including generator's costs associated directly with the waste disposition and administrative and social control costs. List environmental costs and social impacts as part of each threat scenario. Choose an appropriate discount rate, along with reasonable estimates of when threats may materialize. Best engineering judgment should provide reasonable estimates of the probable occurrence of most threats.

Once the preceding eight-step procedure is carried out, an analyst can examine the results for each approach, compare them with overall policy objectives, and modify each approach to optimize the results. When optimization is complete, the decisionmaker can compare the results of different approaches.

Decisionmaking

Decisionmaking may be simplified through several steps. Because hazardous waste management decisions involve value judgments, a decisionmaker must make the final choice among alternatives.

An array of the alternative approaches may be helpful in systemizing the decisionmaking process since there are complex considerations and multiple objectives involved. The method proposed here is to use a balance-sheet format that arranges the costs and threats, their effects on the parties-at-interest, possible responses of the parties-at-interest, and the physical outcomes for each approach. This method serves to simplify the selection of trade-offs among alternative approaches.

The decisionmaking process can be further simplified by eliminating those alternatives that are dominated by others. One approach is said to dominate another if both quantifiable and nonquantifiable costs are clearly higher for one alternative than another, provided that the nature and distribution of the costs is similar for both. Analysis for dominance is a useful way of eliminating approaches without having to fully evaluate some of the costs.

A check should be made at this point to ensure that each of the alternative approaches under consideration satisfies the policy objectives identified earlier. A critical aspect of decisionmaking is to choose an appropriate degree of risk aversion. This choice will generally require trade-offs between added costs and the reduced probabilities that environmental threats will materialize. With the present state of knowledge of risk aversion, selection of the appropriate degree remains the responsibility of the decisionmaker.

The decisionmaker is also responsible for ensuring the equity of costs and benefits to the parties involved within each alternative approach. Identifying parties-at-interest is particularly useful in this step. After examining the ways in which costs and impacts fall on different parties-at-interest, the decisionmaker can devise strategies to render a given approach equitable by shifting some of the costs from one party to another through subsidies, compensation, etc.

Applications of the Methodology

The methodology has been demonstrated by application to two diverse situations. In a hypothetical case, a decisionmaker is required to choose from among alternative techniques for the disposal of a single high-volume waste stream. The analysis concentrates on the costs and threats associated with the various disposal techniques and the attitudes of the parties-at-interest.

The second demonstration involves a case study of hazardous waste management in Oregon. Though this study does not provide sufficiently detailed or comprehensive planning guidance to Oregon environmental agencies, the usefulness of the methodology is evident from this broad analysis. In contrast to the first demonstration, simplifying the data to facilitate analysis is an important part of the procedure, and the use of scoring is illustrated to weight the divergent interests and attitudes of the parties-at-interest.

Both demonstrations show how the decisionmaker's task can be simplified. In the first case, some options can be eliminated since they are dominated by others. In the Oregon case study, certain waste management approaches are eliminated through a series of paired comparisons. In neither case, however, is the final decision clear-cut. In both cases the decisionmaker is required to choose an appropriate degree of risk aversion before reaching a conclusion.

The two demonstrations illustrate the diversity of the methodology and its potential value as an aid in decisionmaking. Other potential applications include analyzing alternatives for the treatment or disposal of a particular waste type on a regional or national level and analyzing nontechnical aspects of emerging disposal techniques as compared with those currently in use.

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The complete report, entitled "Socioeconomic Analysis of Hazardous Waste Management Alternatives: Methodology and Demonstration," (Order No. PB 81-218 968; Cost: $20.00, subject to change) will be available only from:
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