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ENVIRONMENTAL IMPACT ASSESSMENT
FOR WATER RESOURCES PROJECTS:
PLANNING PROCEDURE AND ANALYTICAL METHODS

by
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Thesis submitted to the Department of
Civil and Environmental Engineering of
New Jersey Institute of Technology
in partial fulfillment of the requirements for the degree of
Master of Science in Environmental Engineering
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PLANNING PROCEDURE AND ANALYTICAL METHODS

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ABSTRACT

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Master of Science in Environmental Engineering, May 1989

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This thesis presents a state of the art review of environmental impact assessment procedures utilised in the water resources projects which have evolved over the past two decades. The methodologies employed and some of their limitations which exist and are inherent in both the planning and assessment phases of analysis are identified. The above was supplemented by an investigation of the various views of professionals currently employing the above methodologies. The review effort summarizes the relevant information obtained from the literature which is rather dynamic because of the ever evolving nature of the field. One conclusion drawn from this study is that the recent changes in water planning guidelines are but a pragmatic adaptation to the way planning actually takes place and that multiobjective methods will continue to play a role. Among suggestions offered by this author, in the case of analytical methods are needs for adapting more to the new institutional environment and for greater usage of conflict management techniques. It is believed that some of the recommendations in this thesis would serve to strengthen the process and the projects developed as part of the assessment program.

To my parents

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Chapter I

INTRODUCTION

Environmental Impacts (EI) are a by-product of human activities undertaken to meet the physical and emotional requirements of man. Although modern societies are increasingly able to manipulate the environment to meet their needs for food, shelter and security, it is apparent that the true cost of such actions normally involves some reduction in environmental quality. Therefore, the demand for commodities to support human needs conflict with the desirability of not degrading or destroying environmental resources in the process. Analysis of EI are performed to provide the insight required by society to understand and resolve this conflict of interests.

A. Scope

The National Environmental Policy Act (NEPA) requires Federal agencies to identify and develop methods and procedures which would insure that unquantified environmental amenities and values be given appropriate consideration in decision-making along with economic and technical considerations. Since NEPA came into effect, hundreds of impact methodologies have been developed for systematically comparing alternatives and aiding decision-makers in selecting a proposed action. Many technological procedures for impact prediction have been developed in response to NEPA. Hence, the available literature on both methodologies and technologies has become extensive over the past twenty years since the advent of NEPA. Due to the dynamic nature of the EI assessment literature, it was proposed for this thesis that the literature review of methodologies and Technologies be updated to reflect the evolution of the same. Further, since similar methodologies exist for analysing many different environmental issues, the review was concentrated in the area of water resources projects.

As presently instituted EI assessments for a proposal exist, to a large extent, separate from the planning and development of a project. Assessment experts polled by this author generally felt that a procedure more integrated with the design phase would be preferable as environmental interests would be better served by an early recognition of possible impacts. With this view in mind, recent federal planning procedures were analysed to assess conformance with current thinking of the environmental assessors.

B. Objective

The objective of the thesis herein is to prepare a review of methodological techniques that are used directly in or that have potential application to EI assessment studies for water resources programs and projects. Further, this thesis reviews the use of current planning procedures since there has been sufficient time to analyze the present federal planning guidelines and to judge their effectiveness. Another point of focus was on areas of weakness which presently exist in assessment reporting and are inherent in planning procedures and many assessments produced. Suggestions to remedy some of the problems encountered are presented in the thesis.

C. Description of study

Federal water planners use four general types of procedures to inject social and environmental goals into water planning, management and regulation:

1. Planning procedures, specified by law, or guidelines that outline what is to be measured, which methods are to be used, who must be consulted, what alternatives are to be considered, and the timetable that should be followed. Among these are the now non-existent "Principles and Standards" (P&S) and the current "Principles and Guidelines" (P&G).

2. Analytical methods, usually numerical weighing approaches, for assessing and comparing impacts of alternative plans. More important among these are the environmental checklist, matrix system, network analysis and overlays methodologies.

3. Public involvement techniques that can identify problems and opportunities, provide input on the objectives and priorities of different interests, uncover overlooked impacts, give a sense of involvement and ownership to affected parties, and resolve conflicts.

4. Standards that specify minimum qualities or quantities to be achieved. For example, ambient pollutant standards, the "best available control technology" provisions of the U.S. Clean Water Act, and "rules of thumb" of accepted professional practice.

This study deals with the first two types of procedures.

In the next section, the philosophical perspective on the use of planning procedures and analytical methods to judge and incorporate social and environmental impacts are examined. This can be termed as the "rational-analytical" philosophy.

The next chapter deals with the National Environmental Policy Act. Then the theory, practice and needs of planning procedures and analytical methods are discussed in detail. Finally, after the conclusion are the appendices examining the various topics which can be useful for better understanding of the report.

D. Philosophical context

Rational-analytical philosophy underlines the federal water planning procedures. Central to this philosophy is the distinction between fact and value. "Facts are propositions which can be determined to be true or false by empirical test. Values are statements about good or bad, propositions which cannot be directly tested empirically." [14]

From this comes the idea that planning procedures first identify objectives (values), then formulate alternative solutions (facts), estimate their effects (facts), evaluate the effects relative to the objectives (values), and finally choose among the options. In the political arena, this philosophy is embodied in "redistributive politics", one of the modes of political decision-making. In redistributive politics, first one or more ends for collective action are agreed upon and appropriate means for pursuing those ends are selected. Objectives are chosen by ideological consensus.

The reality of water resource development politics is of course, otherwise. The dominant mode of decision-making is what is called as "distributive politics," the forging of group agreement over a set of actions by vote trading. In this mode, each action addresses the goals of one or more interests, but consensus on those goals is not needed and rarely reached.

However, the assembly of coalitions by distributive politics necessitates the inclusion of increasingly insufficient projects, causing external opposition to build. Paradoxically, both opponents and proponents of development have, as a result, turned to procedures based on the rational-analytical philosophy. Opponents wanted to discredit bad projects and end "pork

barrel" politics by forcing decision making to be explicit and rational. Proponents, on the other hand, hoped that these procedures would grease the skids by giving political decisions a rational veneer. This situation directly led to the adoption by federal water agencies of planning procedures that embody the rational-analytic philosophy.[14]

Federal water agencies needed tools to implement the new planning procedures. This need, plus a belief in the usefulness and rightness of the rational-analytical philosophy, motivated economists and system analysts to develop analytical procedures for evaluating social and environmental impacts. Many of these methods have been made an official part of federal water planning procedures.

Economists tried in vain to develop a theory of welfare economics to define the necessary conditions for identifying a socially optimal pattern of resource allocation. Economists have some success in inventing techniques that can implement this goal by measuring "willingness to pay" for environmental and social goods. This task is not easy, because such goods often lack market prices. An example of the method is a type of pricing, which estimates the value of goods, such as clean water, by statistically regressing the price of a secondary goods, such as land, against the amount or quality of the environmental goods in question.

System analysts, in turn, have contributed to the analytical tool kit of planning procedures by devising methods for multiobjective analysis. The aim of multiobjective analysis is to:

- display the trade-offs that exist between economic, social, environmental and other objectives (facts);
- help people to decide what trade-offs are acceptable and which alternatives are preferred (values).

Yet in spite of these institutional and methodologic advances, the rational-analytic paradigm by no means reigns supreme. Despite a half century's worth of federal genuflections towards this philosophy, water development remains driven by local needs and its midwife is distributional

(log-rolling) politics. Other reasons why the rational-analytic approach fails to triumph include:

- Inability to agree on the ends of water development. Failure to understand how objectives were created. Further, people's values were ill formed and highly inconsistent; as a result, the responses people make to the questions posed by economic and multiobjective methods can be more a function of irrelevant aspects of question phrasing and context than of underlying preferences. It is important to learn to value and to put more emphasis on the testing and revising of values through experience.
- The conflict between federally defined welfare objectives with the more specific and problem-oriented perspective of local project sponsors.
- The incompatibility of the planning perspective of the P&G, in which the emphasis is on trade-offs and evaluation, and the practice of environmental impact assessment, which eschews the trade-off philosophy and instead emphasizes protection of environmental values.
- The questioning of the fact-value dichotomy by many philosophers and social scientists. It was argued that: (1) "Reality" in a planning context was more shared process of creation than an independent observable fact; and (2) what one values would determine which "facts" one believes. If this is true, public participation processes, not just analytic techniques, were needed to arrive at agreement of even the "facts" of water planning.
- The inability of welfare economists to devise a means to make interpersonal welfare comparisons, and the failure of efforts to define a meaningful and generally accepted index of environmental quality.[11]

To those who deplore the inefficient, the shortsighted, and the inconsistent in water development, the failure of the rational-analytic philosophy to take hold may seem at first to be a defeat. Yet if it is a defeat, it is a partial one. Methods based on this philosophy still play an important and positive role in distributional politics: that of giving the various parties the means to: (1) Devise plans which better serve their interests; and (2) more effectively argue their case. They have helped to separate and highlight the federal interest (maximizing national economic development, in the case of the P&G), while achieving local objectives (the solving of particular water problems). From the perspective of the rational-analytic philosophy, these methods have been, and will surely continue to be "abused"- that is, used to rationalize the seemingly irrational. Nevertheless, the whole, their use as a partisan tool in politics has served to: (1) Raise the level of debate; (2) make decisions replicable; (3) provide an accounting system by which projects proposed by different agencies can be consistently compared; and (4)

screen out many of the worst projects. These are considerable accomplishments.

Chapter II

NATIONAL ENVIRONMENTAL POLICY ACT

On January 1, 1970, the President of the United States of America signed the National Environmental Policy Act (NEPA), PL 91-190, into law. The enactment of this legislation established a national policy of encouraging productive and enjoyable harmony between man and his environment. The symbolism of the timing of this law did not go unnoted by the President and other (and other) concerned Americans, who heralded the 1970's as a decade of environmental concern. Enactment of NEPA and concern regarding the environment and quality of life among people around the world have generated significant environmental protection legislation and regulations in many industrialized nations besides the USA.[12]

The main purpose of this legislation, as set forth in the Act, is "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation; and to establish a Council on Environmental Quality (CEQ)."[19]

Effects of NEPA have been far-reaching. When the environmental costs, as surfaced because of the requirements of NEPA (i.e. documentation of an EI statements are made known to the decision makers at various official levels to the public) modification, delay or abandonment of the project may be necessitated.

While environmental analysts and decision-makers were wrestling with quality, lawyers were more concerned with proper procedure, and a body of case law began to accumulate. Many federal agencies suffered legal

indignities during the 1970s because of procedural non-compliance with NEPA. However, the courts remained reluctant to judge the scientific quality of environmental analysis.

The proponent agencies, as a result of court cases and judicial review, and in order to comply with the requirements of NEPA, must also do the following:

- satisfy the Act's full disclosure requirements with adequate detail (i.e. include significant Eland the relationship of the project assessed to other related projects);
- adequately consider the alternatives to the project;
- make genuiene efforts to mitigate any major impacts on the environment due to implementation of the project.

The CEQ regulations, which became binding in mid-1979, establish specific criteria for environmental analysis under NEPA. The direction of the judicial process under these regulations is not clear. In the future, courts should be more willing than in the past to scrutinize the quality and substance of a decision as well as its procedural compliance. This will make sure that the agency has not acted arbitrarily and capriciously in decisions when dealing with environmental cosiderations.

Among the frequently voiced concerns about the implementation of NEPA are:

- that impact statements are not available in time to accompany proposals through review procedures;
- that statements are prepared in 'mechanical compliance' with NEPA;
- that impact statements are biased to meet the needs of predetermined program plans;
- that agencies may disregard the conclusions of adverse impact statements;
- that CEQ lacks authority to enforce the intent of NEPA;
- that the intangible environmental amenities are being ignored;
- that secondary effects are being ignored; and
- that inadequate opportunity is available for public participation and reaction.

A fundamental problem facing those trying to comply with NEPA centers around the word 'significantly'. Although the NEPA regulations discuss the term, they provide no clear definition of 'significance' that can be applied objectively and uniformly to environmental issues and the consequences of man's activities. A critical question, then, for federal agencies is to determine when an environmental impact is significant, and when it is not. If an EIS is required, based on 'significant' impacts, costs in time, effort and money can be much greater than if impacts can be documented in an environmental assessment (EA). Both these terms (EA & EIS) have specific legal meanings (CEQ, 1978), and the determination of whether one or the other will be prepared hinges on the word 'significantly'.

It is estimated that over 15,000 EI statements have been prepared and well over 20,000 EI assessments have been conducted.

Chapter III

PLANNING PROCEDURES

A. Theory versus B. Practice

To many analysts who had labored long and hard developing rational-analytic (economic and multiobjective) techniques for evaluating environmental and social impacts, the P&G and the weakening of the federal role could be viewed as a step backward. In theory, the multiobjective approach was tossed out and the myriad measurements of environmental effects that were required by the P&S are now merely voluntary.

But in practice, nothing much has changed in planning. In fact, it can be argued that the P&G are simply a pragmatic adaptation to the manner in which planning was being conducted.[25]

In practice, the P&S confused federal planners. Under the P&G, planners remain confused. One source of confusion is the proliferation of laws and regulations in the 1970s. Another is the difficulty planners have agreeing on how to integrate local planning objectives ("problems and opportunities") with federal planning objectives. A third is that recommended methods were often not far enough up the "learning curve" of methodologies to be used correctly and routinely. An example of the latter is the premature endorsement by the P&S and P&G of "bidding games" as the preferred means for eliciting contingent evaluations. Subsequent research demonstrated that the bidding game format is very vulnerable to certain biases.

In practice, environmental and social effects are probably given as much consideration as ever. There are 29 laws to be given recognition ranging down the alphabet from the American Folklife Preservation Act to

the Wild and Scenic Rivers Act. Executive Orders to be followed include (among others) Protection and Enhancement of the Cultural Environment, Floodplain Management, Protection of Wetlands, and Protection and Enhancement of Environmental Quality. There is also reference to various Council of Environmental Quality memoranda and to Migratory Bird Treaties, as well as to various other established federal policies.[22]

In practice, the most successful implementation of national environmental goals has resulted not from vague planning "standards" and heroic efforts undertaken to catalog, measure, and commensurate environmental variables, but from targeted laws - laws focusing on protecting endangered species, wild rivers, and migratory wildfowl. Also, these statutes so constrained the P&S as to reduce their multiobjective nature. On the other hand, they admit environmental objectives into the P&G while softening its emphasis on economic efficiency. The environmental impact statement process has provided agencies such as the U.S. Fish and Wildlife Service an effective means of bringing these environmental standards into the P&G planning process.

Finally, in practice, there is little multiobjective planning, as classically defined, going on under the P&S. Rarely are trade-off frontiers (also known as noninferior sets) generated and displayed. Likewise, multiobjective techniques, such as utility theory or goal programming, for measuring and applying the priorities of interested parties are infrequently applied. Yet, there is as much (and perhaps even more) multiobjective planning occurring under the P&G. The explanation to the above is that under the P&G, formal multiobjective trade-off analysis is conducted by federal agencies. The reason is that it took virtually the entire decade to understand and reformulate the P&S into pragmatic procedures.

The official approach of the P&G has been to establish thresholds for the standards of environmental quality that have evolved from legislation and negotiations with environmentally oriented Federal agencies, within these constraints, the development oriented agencies attempt to maximize National Economic Development (NED). The practice planning model evolved

under the P&S reflected an emphasis on maximizing the project purposes that were specified in authorizing legislation. This was accomplished with an eye towards minimizing the negative, but largely, localized impacts. The planning practitioners viewed social and environmental issues from an impact -and constraint-oriented perspective rather than as positive goals to be achieved. There are two reasons for this. First, many social objectives are being attained through project purposes. Second, environmental needs are often met by a combination of recreational outputs and habitat mitigation.

Meanwhile , explicit roles for multiobjective analysis under the P&G can be considered absolutely fine. The reason is that although P&G subtly changed several assessment ideas along with the associated terminology, they did not fundamentally alter the broad assessment framework and the capability to express social and environmental objectives. Under the P&G, federal plan remains a two-tiered assessment process that still accomodates multiple objectives. The two tiers were a "screening" phase and "feasibility" phase. In the screening phase, multiobjective methods were perfectly suited for examining a large number of options and eliminating those that are either: (1) Dominated in all objectives by other options; or (2) represent unacceptable compromises of important objectives. The final set of candidate plans that emerge are then further developed and optimized with respect to the scale and combination of outputs (recreation, flood control, mitigation etc) using primarily the NED objective.

Thus P&G still encourages the formulation of plans that further other objectives. It seems to be a tacit admission that several existing statutes, such as NEPA and Water Quality Act amendments, may require that a water plan emphasizing contributions to environmental quality be developed. In any event, the work involved in developing an EI statement, required by NEPA, will still remain. Since it is understood that, the work on the EI statement has largely supplied the principal elements of the previously required (by the P&S) plan emphasizing contributions to environmental quality, it is apparent that the substance of such a plan still remains.

C. Needs

Conclusions on evaluative criteria in federal planning procedures include:

- Present regulations and laws should be sufficient to perform reasonable assessment for projects incorporating environmental and social concerns.
- Though the P&G appear to be an acceptable and flexible framework for assessment processes, there exists difficulty to understand and apply, and to date there exists insufficient experience to fully determine their adequacy.
- A potentially serious weakness within the assessment process is identified as the training, education and management of the personnel who are actually performing the assessment. Many lack experience.

Critical to the effort to making the P&G more understandable and effective are by engineers and scientists to bridge the gap between: (1) Vague, conflicting, fuzzy criteria provided by interest groups on social and environmental needs: and (2) hard quantitative measurements of the environment of the sort engineers and scientists are comfortable with.

One shortcoming of federal planning procedures concerns the degree of protection provided in situations, such as flood control or water quality, where there are substantial positive or negative nonquantifiable benefits. It may be argued that planning methods have done a poor job of balancing incremental benefits and costs in such cases. The result has been projects in which incremental costs have far exceeded the benefits. Choosing proper project scale is difficult enough when all impacts are monetizable; when they are incommensurable and intangibles, the task becomes all the more difficult. There is a need to make technical standards for safety and water quality more flexible in such cases, and allow all interests to have a voice in those decisions. [13]

Chapter IV

ANALYTICAL METHODS

A. Theory

The field of EI statement preparation was pioneered as a response to the far reaching provisions of the NEPA of 1970. Various methods and techniques are developed to facilitate compliance with the Act (see Appendix A for an outline of the important methodologies).

EI assessment methodologies are designed to identify, integrate, interpret and communicate environmental impacts from implementation of proposed projects. Methods for assessing impacts can be classified as follows:

- Methods for selection of evaluation criteria - the decision rules or constraints in the assessment process. An example would be using the criteria identified in the P&G, NEPA and other laws.
- Procedures for ranking options. Examples would include benefit- cost analysis and multiobjective programming.
- Methods for identifying attributes and impacts of concern. (e.g. checklists, scoping). Attributes are defined as measurable or describable properties of projects and resources, such as dissolved oxygen levels.
- Methods for measuring individual attributes and impacts. Examples would include physical monitoring, risk estimation.
- Procedures for displaying trade-offs among alternatives such as computer graphics and tabular displays required by the P&G.

Environmental impact analysis can be defined as a process aimed at the recognition of causes and effects, a cause being any action of the proposed project affecting the environment. The effects are the environmental impacts of the action. Any effect on the biophysical and socio-economic environments that arises from a cause directly related to the project is termed

a "direct" or "primary" or "first order" impact. "Indirect" or "secondary" or "second order" impacts are those effects on the biophysical and socio-economic environments which arise from an action, but which are not initiated directly by that action. Their occurrence is defined by the interdependencies which exist within and between the two systems.

There are several reasons for using analytical methods. Perhaps the paramount one is to ensure that valid planning objectives are directly integrated into plan formulation and assessment. Otherwise, in the absence of formal, replicable methods, planning could be skewed by ad hoc and inconsistent applications of methods that may not fully reflect the goals of the reigning assessment principles.

Multiobjective analysis attempts to help EI assessment in the following ways:

- By widening the range of impacts considered beyond those which are easily monetized.
- By displaying, in a vivid manner, the trade-off among different objectives.
- By eliminating dominated alternatives.
- By helping to make value judgements about trade-offs more consistent and rational.

The history of rational-analytic procedures for judging social and EI is one of raised expectations and subsequent disappointments. Until the recent adoption of the P&G, such techniques played an increasingly important role in the federal water resources planning process. Great strides in theory and application are made by researchers.

B. Practice and needs

Unhappily for the society as a whole, analytic EI methods have not fulfilled their promise. Too many methodology problems remain to be tackled effectively.

Choosing a method:

Arguments range among champions of different techniques resulting in confusion. No wonder users often throw up their hands and decide to use whatever technique happens to be the most convenient (see Appendix B: Psychological Biases in Environmental Judgements). The debate on the choice of method matters to a very significant extent. Several experiments have found that what method was used can make more of a difference than who applies it.

To build confidence in the methods and help avoid misapplications, it is important for users to carefully consider the pros and cons of different methods, and for researchers to conduct experiments and comparisons that make this information available. Four possible criteria for "choosing how to choose" are described below.

- Method appropriateness is critical. Is the technique suited to the organization's evaluation philosophy (eg. the P&G)? Does it use available data effectively, and does it yield the type of information needed by planners and the public? Does the method ask for value judgements by planners or the public in a manner they can respond to meaningfully?
- Ease of use is important because of the limited time, personnel and information available to most planning agencies.
- A method has validity only if it can accurately measure what it purports to. Are the methods' assumptions and the evaluations it yields consistent with values of the users? Is the method on a solid theoretical footing?

- Finally, whether choice of method matters should be considered. If the plan chosen depends on the method applied, then validity is important; if not, then one can simply use the easiest approach.

Review of the methodologies indicate that the dominant trend has been toward an inflexible reductionist and mechanistic approach. Rigid logico-mathematical frameworks, often derived from other fields, have been manipulated for impact analysis.

The usefulness of developing new, integrated environmental impact assessment methodologies is questionable. Instead, more substantial progress may be made by first evaluating the assessment methods already available in relation to the specific tasks - of identification, measurement and prediction, significance assessment and communication - which they are expected to perform. Considering the complexity of the interacting systems that constitute the environment, and the infinite variety of possible impacting actions, it seems unlikely that a single method would be able to meet all the criteria. The general applicability of all methods also has to be balanced against the values of the society and administrative constraints within which they are employed.

Multiobjective Methods :

In practice, federal agencies infrequently applied analytical multiobjective methods. This was in spite of vigorous promotion of these methods by the research community and their enshrinement in the federal planning procedures. When the methods were applied, they were often used to

rationalize decisions, rather than to improve them. In some cases, these assessment methods may be used to justify a decision dictated by the political process.

Some proponents of multiobjective methods believe that economic methods are ill-suited for evaluating social and environmental impacts. There are economists, on the other hand, who maintain that multiple objective planning is inferior to the 'correct' procedure of inputting monetary values to all effects that do not have market prices.

In practice, ultimate judgements regarding the weights given to social and environmental values in setting those priorities are left to processes that depend upon less formal analysis. There is little evidence that the alternatives are constructed to reveal differences in benefits and costs to those as well as other values. Multiobjective methods also need to be improved to better handle the uncertainties and risks involved with all water development. [11]

Rational-Analytic Methods :

In practice, there are reasons why social and EI assessment methods based on the rational-analytic philosophy have limited foothold in the decision-making process. They have been used for such a short period of time that they have not yet been fairly tested.

These methods are guided by explicitly defined goals, and have not yet become successful in defining objective functions - especially for intangible social and environmental concerns. Another problem is regarding the non-inclusion of distribution of benefits and costs in the analytical

framework. This offers little help to politicians and mediators whose principal business is to forge agreements among divergent interests.

An effort is also needed to respond to the challenge of public participation and conflict management. There are three ways to use rational-analytical models in conflict management: to analyze interpersonal relations, to provide information and to generate a final decision. Rational-analytical models can be used to provide and display information in a systematic way so that decision-makers can easily understand the implication of choosing one alternative or modification over another. They can be particularly useful when there are a large number of interacting variables that must be considered; and/or there is uncertainty related to basic assumptions or the validity of input data. In the latter case sensitivity analyses or 'what if' scenarios can be generated by the model.

Recent institutional changes may result in greater use of rational-analytic methods. Resource development is giving way to resource management. State, regional and local programs are replacing federal ones and as a result, distributive politics will be less predominant at lower levels of government, where it will be more difficult to shift costs to third parties. Finally, rational-analytical approaches will become more important provided that major conceptual problems in their application to group decision-making can be resolved.

Adaptive Methods :

Upto this time, no consideration has been given to the compatibility between the provisions for EI assessment and the form of EI analysis methods. EI assessment is not an economically profitable activity over the short term. Therefore, the social preference for a consideration of environmental cost is normally reinforced by legal provisions. The types of analysis

methods which will be acceptable in a particular situation are thus related to the level of commitment embodied in the relevant legal provisions.

Adaptive methods have been developed in an effort to extend the capabilities of EI analysis. The tendency to view multiobjective and benefit-cost techniques as competitive and mutually exclusive should be avoided. By complementing each other's advantages, more effective and trust worthy analyses can result. In fact, they can act as checks to each other, with the result that values have been tested and can be improved: in particular, made more coherent.

The results of multiobjective methods are often unreliable. Benefit-cost analysis, too, has its problems: an inability to deal with intangibles and a need for larger amounts of trustworthy data. Combining the strengths of the two approaches would lead to an overall assessment procedure that is stronger and more defensible. Although determining which alternative is really best cannot be done objectively, it does appear that a process that combines the best features of the above two approaches could yield a better choice in terms of being more consistent with the values of both local residents and the nation as a whole. Such a process would also promote learning and testing of values, since assessments from one approach would be compared for consistency with the other.

Planners & Developers :

Developers of assessment methodologies and the planners who use them are responsive to different technical stimuli and have difficulty in

communicating their perspectives and needs to each other. Methodology developers typically respond to major pressures such as the professional community, their peer group and interpretation of NEPA. Planners face different pressures such as the agency's objectives and constraints, guidelines for project justification, operational deadlines, desires of other agencies and special legal requirements. Yet this variety of individuals have the responsibility of preparing project plans which must balance environmental, social, economic, and engineering considerations.

Methodologies should be made more responsive to the needs of the planner. The methodology should make the job of preparing the assessment easier. The planner needs both detailed instructions to prepare the assessment and the flexibility to make modifications in the instructions when necessary. The data required by the methodology should be closer aligned to that available to the planner.

The Political Touch :

NEPA has given political character to the bureaucratic procedures by which Federal agencies plan and implement projects. This has implications for the types of methods likely to be used in the future impact analysis is less often seen as a technical exercise likely to result in better more rational decisions. Impact analysis is now seen as an integral part of the political process which surrounds all proposals. It is considered to be an input to political processes which involve the proponent, local people and national interest groups. (see Appendix C for interest groups activities)

Post-development Monitoring and Mitigation Techniques :

In truth, all assessments are confined to a time prior to the commencement of the project. The spirit of legislating the preparation of assessments does caution applicants regarding the possible negative impacts of the proposed project. However, not all resultant impacts after development can always be recognized by both applicant and reviewing bodies even assuming all parties are acting in good faith. This cloud of concern can be tempered with the inclusion of post-development monitoring and mitigation techniques to insure compliance with environmental regulations.

One of the techniques to combat the above problem can be to combine methods in a sequential manner to analyse progress from a simple investigation of major impacts to a more detailed study of the areas of concern. There are methods (eg. matrices, overlays, checklists, networks) which can be used in the preliminary stages of a project to guide development in a direction of minimized environmental impact. This is achieved by communicating the more obvious environmental implications of a project. Once developed, more detailed methods (eg. system diagrams, weight-scaled checklists, dynamic models) can be used to assess the more complex implications of the project proposal, and to evaluate the possible mitigatory measures, and environmental management strategies.

Advanced and preliminary approaches to EI analysis should not be seen as separable activities. It should be the task of preliminary methods to focus attention on important aspects and to create a data base from which advanced methods can develop. Output from both stages can be incorporated in an EI statement for final evaluation of a project.

Wildlife :

Often decisions of approval or denial occur in major projects which hinge on whether the proposal will or will not adversely impact on threatened or endangered species. At present, Contingent Valuation Method (CVM), also known as the Bidding Method, provides the standard for valuing wildlife in Ellassessment. This method is used widely and is recommended by an interagency committee of the FederalGovernment, that puts all values on a commensurate basis (net willingness to pay). The types of surveys used in CVM are subject to several possible types of error, including what has become known as 'hypothetical'bias, strategic bias and information bias (where bias is not used in the statistical sense). It is generally acknowledged that careful survey design can minimize these influences, and, in empirical work, these influences are often not observed. Comparision studies have also indicated that CVM values tend to be conservative.

Refinement in the conceptual basis for valuing wildlife and economic measurement techniques are clearly needed. As more understanding of mitigation measures are recognized, designs could be effected which probably would allow more projects to be built while also insuring the integrity of the resident fauna.

Competence in Assessment :

Part of the lack of analytical procedures can be traced, paradoxically, to overenthusiasm. Inappropriate use of the wrong techniques by inexperienced users has inevitably lead to practitioners being suspicious of claims made for these techniques. Quantitative methods can help improve decisions; but their misapplications can obscure important issues, distort people's values, and skew decisions. Lack of information on the relative strengths and weakness of different evaluation methods is a major cause of misapplication. So, too, is misunderstanding of method assumptions and limitations.

Presently, there are no specific requirements for preparers of EI assessments. Furthermore, there are no requirements that preparers of specific chapters within an assessment documented be identified.

It is recognised that the multi-disciplined nature of EI assessment precludes a reasonable formal education in all areas of assessment to render one an 'expert' assessor. Nonetheless, assessors need to be certified and/or licensed to demonstrate their competence. This would provide the general public with some degree of assurance that the professionals are competent and that they are held responsible for their findings and actions.

Role of Communication :

Communication methods should be developed which are based upon a sufficiently broad view of the role of communication in the EI assessment process. Although it is important to produce clear and intelligible studies and make effective provision for comment upon these, the role of communication extends beyond this. At the heart of the matter is the choice of "consultation model" to use within EI assessment.

The more traditional view emphasizes the divergent interests of the parties involved in EI assessment and seeks to reach a solution through mediation, if none of the parties can be neglected when reaching a decision. The alternative view emphasizes the development of trust relationships and the resolution of differences between the parties through communication and consultation at each important stage in the EI assessment process. The choice between the two "models" may not only determine the most appropriate methods of communication to be used, but also the direction in which EI assessment as a whole evolves in the future.

Identification Process :

Probably most attention has been paid so far to the identification task. However, this has encouraged an encyclopaedic approach to data gathering (in turn, generating its own adverse reaction), and therefore the requirements of a more selective identification approach to the collection of the most relevant data need to be developed. More attention should also be given to

the better identification of alternatives and to avoiding errors through double-counting when preparing assessment.

Decision-Making Process :

Determining the significance of environmental impacts for use in decision-making is probably the least satisfactory aspect of EI assessment at present. The extreme forms of handling significance assessment—highly aggregated scaling/weighting systems or, alternatively, burdening the decision-maker with too many items of complex environmental information—have not succeeded, and this partly explains the limited progress in integrating assessment into decision-making processes. There is a need to close the substantial gap between what analytical methods can do and what decision-makers would like to know.

The assumption that the success of impact analysis depended on the presentation of scientifically accurate EI statements, leading to 'better' decision-making, has come under close scrutiny. It has been argued that more 'scientific' EI statements might actually harm the environment. It is considered that deleterious projects have been altered or stopped because of litigation and public pressure, not because the contents of particular EI statements directed agency personnel to the correct decision. Should EI statements become more scientifically accurate, certain options for influencing agency behavior through court action might be closed. An adequate EI statement is more difficult to challenge in the courts. However, approaches need to be developed and tested in practical situations.

Chapter V

CONCLUSION

While the effectiveness, and the quality of impact assessments may be debated it is unlikely that the intent guiding their creation will ever be abandoned. The environment impact assessment process has mainly been a positive factor in project design and development. Furthermore, environmental risks and liabilities should diminish as environmental impact assessment program matures and actions are taken accordingly. Toward this end, recommendations in analytical methods stated herein include the following areas: Choosing a method, Multiobjective methods, Rational-Analytic Methods, Adaptive Methods, Planners and Developers, The Political Touch, Post-development Monitoring and Mitigation Techniques, Wildlife, Competence in Assessment, Role of Communication, Identification Process, and Decision-Making Process. Some of the recommendations, in the above areas and in the planning procedure, are hoped to strengthen the process and projects developed as part of the assessment program.

APPENDIX A

ASSESSMENT METHODOLOGIES

Environmental impact methodologies can be basically classified into four types or structures depending upon the way the impacts are identified.

1. *Overlays*: These methodologies rely on a set of maps of environmental characteristics (physical, social, ecological, aesthetic) for a project area. These maps are overlaid to produce a composite characterization of the regional environment. Impacts are identified by noting the impacted environmental characteristics lying within the project boundaries.

Overlays are often used in route or corridor methodologies. The approach is only moderately comprehensive and presents some difficulty in identifying specific project impacts. In addition, there is often a problem in obtaining or selecting the necessary data for the analysis.

2. *Checklists*. These methodologies present a specific list of environmental parameters to be investigated for possible impacts but do not require the establishment of direct cause-effect links to project activities. They may or may not include guidelines on how parameter data are to be measured and interpreted.

The checklist is the most common type. It can provide a very comprehensive assessment, but can also lead to voluminous and disorganized reports. In addition, a list may lead reviewers to overlook factors that are not explicitly stated. Because of its format, the impacts are easily communicated and used to compare alternative plans.

3. *Matrices.* These methodologies incorporate a list of project activities in addition to a checklist of potentially impacted environmental characteristics. These two lists are related in a matrix which identifies cause-effect relationships between specific activities and impacts.

Matrices are useful in identifying and displaying the impacts of specific project activities on the environment. However, their structure is not conducive to the comparison of alternative plans. The matrix approach is comprehensive, but the numerous possible interactions can often lead to unnecessary analysis. Evaluation of secondary impacts is also a problem with this structure.

4. *Networks.* These methodologies work from a list of project activities to establish cause-condition-effect networks. They are an attempt to recognize that a series of impacts may be triggered by a project action. These approaches generally define a set of possible networks.

Networks, like matrices, are useful in identifying and displaying the relationship of various project actions to environmental impacts. However, their structure is not conducive to the comparison of alternatives. In addition, the network can become so extensive that the resulting analysis would have limited practical values.

APPENDIX B

PSYCHOLOGICAL BIASES

Faced with a complex, often threatening environment, man seeks to achieve some degree of understanding and control of the physical and social worlds. Indeed, the feeling of control, even if it is illusory, is central to a person's health, for, without such feelings, man becomes immobilized, prone to mental breakdown. Numerous studies have shown that lay people and professionals show excessive over-confidence, both in the quality of their judgements and in the degree to which they believe they can control events. For example, the illusion of control can be created by simply writing about or doing research on a topic, regardless of the actual consequences of that activity. In another vein, many professionals tend to show over-confidence in their rather limited abilities when they imply that what they know they know very well indeed, and what they do not know is unimportant. Similarly, studies on the relationship between the quality of decision-making and amount of information, found a consistent pattern of over-confidence. Thus, while confidence increases with the amount of information available, the actual quality of decisions starts to decrease after modest level of information was reached. People, including experts, use much less information than they believe they do and they are generally unaware of how they make inferences during decision-making. One consequence of this over-confidence and lack of awareness is that biases go unnoticed, so that precautions which might be taken to ameliorate their more negative effects are not taken. This consequence is unfortunate, to say the least, because the complexity of environmental problems and the information overload on most issues force man to resort to a variety of simplifications when reaching decisions. The simplifications, which may have a primary cognitive (heuristic, rule of thumb) or motivational (wishful thinking) basis, invariably bias judgement.

Biases result from an interaction between a complex environment and human limitations. Environmental problems are more ambiguous, and include psychosocial as well as technical aspects. In addition, environmental

problems involve a profusion of low probability events, an area of decision-making which has proved exceptionally difficult for the human mind. Thus biases are inevitable.

The prevalence of psychological biases in environmental problem-solving and decision-making suggests that the notion of objective judgement is an illusion. Where such biases are ignored or remained undetected, the problem-solving process may be diverted along unproductive lines, leading to inappropriate decisions. In addition, biases operating at a covert level often lead to conflict over the interpretation of data or the formulation of the problem at hand. In the face of these difficulties, it is reasonable to suggest that more attention should be given to the recognition of biases, as well as to finding ways of reducing their more detrimental effects.

APPENDIX C

LOBBYING TACTICS

Grass roots lobbying is considered a time-honored strategy for interest groups attempting to influence Congress. Since the founding of the Republic, organized interests have voiced their demands to representatives and senators through their adherents in the constituency; and in the modern era of mass communications and direct mail, lobbying organizations have undertaken systematic mobilization of their members to create public pressure for their legislative agendas. Letter-writing campaigns, telephone alerts and other grass roots techniques are now standard items in the lobbyists' arsenal, and most groups report employing these tactics with greater frequency than in the past.

Groups rely on members back home to press their case because such expressions of citizen support legitimize their claims. Lawmakers who stoutly resist the arguments of "special interests" will give the same views serious attention if they have a constituency connection. Consequently, grass roots campaigns generally are perceived on Capitol Hill as being very effective.^E

Environmental organizations provide an excellent example for grass roots lobbying. Throughout the bitter struggles over landmark legislation passed during the 1970s, observers of the congressional scene credited the environmentalists' mobilization at the constituency level with their unprecedented success in defeating the coalitions of business and labor interests arrayed against them. This interpretation of the legislative record was credible for two reasons. First, individuals who joined environmental organizations tended to be affluent, well educated and politically active types who typically dominate congressional politics in the constituency. Second, financial constraints prevented these groups from establishing extensive Washington operations. Like most public interest organizations, their small, underpaid staffs necessitated a heavy reliance on alternative tactics of

influence, including constituency mobilization. This strategy has continued into the 1980s, judging from a recent survey of interest groups in which orchestrating grass roots lobbying is the most frequently mentioned activity to which public interest groups devote time and resources. A closer look at the individual citizens who belong to environmental organizations reveals how well-suited they are to the role of advocate for their groups' agenda. They have intense feelings about environmental issues, see their group membership in purposive terms, and are politically active.

Environmental activists have a strategic advantage in attempting to influence Congress if they choose to act as advocates for their groups' legislative agenda; they are well situated to command the attention of lawmakers, and they appear to exercise that prerogative on a regular basis.

Finally, there seems to exist a modest relationship between senators and their active constituents and some of the complexities of this relationship have become quiet apparent. These results are the essence of the grass roots connection between lawmakers and organized constituents.

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