Understanding Uncertainty in Cost-Benefit Analysis and Impact Assessment

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FOREWORD

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Dear Sir:

In the affair of so much importance tc you, wherein you ask my advice, I cannot, for want of sufficient premises, advise you what to determine, but if you please I will tell you how. When those difficult cases occur, they are difficult, chiefly because while we have them under consideration, all the reasons pro and con are not presented to the mind at the same time; but sometimes one set present themselves, and at other times another, the first being out of sight. Hence the various purposes or inclinations that alternatively prevail, and the uncertainty that perplexes us. To get over this, my way is to divide half a sheet of paper by a line into two columns; writing over the one Pro, and over the other Con. Then, during three or four days consideration, I put down under the different heads short hints of the different motives, that at different times occur to me, for or against the measure. When I have thus got them all together in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason pro equal to some two reasons con, I strike out the three. If I judge some two reasons con, equal to some three reasons pro, I strike out the five; and thus proceeding I find at length where the balance lies; and if after a day or two of further consideration, nothing new that is of importance occurs on either side I come to a determination accordingly. And, though the weight of reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered, separately and comparatively, and the whde lies before me, I think I can judge better, and am less liable to make a rash step, and in fact I have found great advantage from this kind of equation, in what may be called moral and prudential algebra.

Wishing sincerely that you may determine for the best, I am ever, my dear friend, yours most affectionately.

B. Franklin, London, September 19, 1772

As quoted in Downs and Larkey (1986, pp. 107–8).

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1.0 UNDERSTANDING UNCERTAINTY IN COST-BENEFIT ANALYSIS AND IMPACT ASSESSMENT

It is becoming increasingly common for large public-sector projects to generate substantial controversy during the public hearing phase of an impact assessment. This controversy often **centers** around estimates of project costs and benefits because of the uncertain nature of project impacts, whether environmental, economic or social.

Cost- benefit analysis is often used as a guideline for making decisions about whether or not to proceed with a public-sector project, and impact assessment processes are frequently structured to determine a project's "correct" cost/benefit ratio. Uncertainty makes this correct cost/benefit ratio difficult to determine. But uncertainty exists not only in the estimation of physical impacts; it exists throughout the process of conducting a cost- benefit analysis.

The tasks involved in conducting a cost-benefit analysis or impact assessment are:

1. the definition of a problem;
2. the definition of goals and objectives;
3. the identification of project alternatives;
4. the identification of the consequences of each alternative; and
5. the evaluation of consequences and alternatives, and the selection of an alternative **(Lindblom,** 1965; Bradley, 1973; Coleman, 1977; **Hollick,** 1981).

The types of uncertainty that exist in cost-benefit analysis relate to each of these tasks; **they** are conceptual uncertainty, ethical uncertainty, factual uncertainty, predictive uncertainty and **evaluative** uncertainty, respectively (adapted from Quade, 1975).

The purpose of this paper is to identify and describe the types of uncertainty in cost- benefit analysis and demonstrate how different versions of a cost-benefit analysis can exist for the same project, with each version having some claim to validity. A single "correct" cost-benefit analysis is rarely, if ever, likely to exist

Chapter 2 traces the development of publicsector project evaluation from the development of cost-benefit analysis in the 1930's to the introduction of environmental impact assessment in the 1970's and describes the similarities and differences between the two concepts. Chapter 3 identifies the sources of uncertainty in problem formulation, the definition of objectives, the generation of alternatives and the identification of consequences Chapter 4 looks more closely at the cost-benefit evaluation literature to determine how analyses might differ through the application of different evaluation techniques, and also discusses the value judgments implicit in cost-benefit analysis. Chapter 5 then describes an actual impact assessment process (the review of the Site C hydroelectric project in B.C.) to illustrate the presence of conceptual, ethical, factual, predictive and evaluative uncertainty in a real situation. And Chapter 6 summarizes the major points brought out in the preceding chapters.

2.0 FROM COST-BENEFIT ANALYSXS TO ENVIRONMENTAL IMPACT ASSESSMENT: A HISTORY OF PROJECT EVALUATION

Environmental impact assessment **(E.I.A.)** is part of the continuing evolution of project appraisal that began with the development of cost-benefit analysis (C.B.A.) in the early 1930's. The use of cost-benefit analysis in government decision-making is intimately linked with the development of project evaluation for water resource developments in the United States. Formal project evaluation techniques for public sector projects developed in the 1930's when the U.S. government began undertaking major water resource projects such as navigation and flood control. Such projects were undertaken as part of national policy rather than by individual states or by private business because of weak state efforts in flood control, the large scale of projects, and a lack of private capital (Ehrhardt and Ehrhardt, 1980, p. 94).

Controversy over these large resource developments began to arise because many of the projects resulted in financial losses and created conflicts with downstream users (Rees, 1985). As a result, the government was increasingly faced with pressure to justify project developments and maximize its real returns on investment The question arose: "HOW was the public to judge whether a local water resources project benefitted the whole nation?" (Ehrhardt and Ehrhardt, 1980, p. 95). It seemed no longer acceptable to leave decisions about such major projects to the "political realm where logrolling and porkbarrel politics often predominated the choice" (Ehrhardt and Ehrhardt, 1980, p. 95).

The solution to the controversy over project evaluation was the introduction of cost-benefit analysis under the U.S. ***Flood Control*** Act of 1936, signalling the introduction of the "rational comprehensive" approach to planning and decision-making in the **natural** resources realm Cost-benefit analysis "gave politics a rationale similarly rigorous to that of profitability in business but which would also rate a project's worth according to the **national** welfare" (Ehrhardt and Ehrhardt, 1980, p. 95). The ***Flood Control*** Act required that "benefits to whomsoever they accrue are in excess of estimated costs" (in Pearce, 1983). This simple rule remains the basic premise of cost-benefit analysis today. CBA attempts to determine whether or not a public expenditure or public policy contributes to the national welfare: "cost benefit analysis purports to be a way of deciding what society prefers" (Dasgupta and Pearce, 1972, p. 19). Any project that contributes to national welfare is a benefit, while any effect that deters from it is a cost (Dasgupta and Pearce, 1972, p. 19; Downs and Larkey, 1986, p. 108). However, the interpretation of this rule in the . 1980's differs considerably from the interpretation common in the 1930's. During the 1930's the interpretation of the requirements of the *Flood Control Act* developed in two ways. First, costs and benefits were usually interpreted as economic costs and benefits; little attention was given to the environmental and social impacts of projects. Second, practical applications of cost-benefit analysis developed an economic- efficiency perspective; national social welfare was interpreted narrowly as economic welfare (see, e.g. Little, 1957, p. ; Dasgupta and Pearce, 1972, p. 12). Other social goals such as income redistribution or environmental quality did not enter the cost-benefit equation.

The narrow focus of cost-benefit analysis that resulted arose from several forces. Because the government was under pressure to justify its large expenditures on water projects, costs were regarded as the financial costs of construction and operation (Pearce, 1983, p. 15; Rees, 1985, p. 306). Similarly, benefits came to be regarded as economic benefits. The definition of benefits was obscure in the *Flood Control Act* and interpretations by various federal agencies were resultingly inconsistent (Dasgupta and Pearce, 1972, p. 12). More significantly, the use of cost-benefit analysis developed separately from the theory of welfare economics (Dasgupta and Pearce, 1972, p. 12; Pearce, 1983, pp. 14-5). Cost-benefit analysis during the 1930's and 1940's was a technique in search of a theory, and as a result was prone to some haphazard development and interpretation.

By the decade of the 1950's, cost-benefit analysis had begun to receive more widespread application in government decision-making. It became evident to government that some formalization of procedures was needed for defining costs and benefits (Dasgupta and Pearce, 1972). A U.S. inter-agency report published in 1950, ***the Green Book*** (Subcommittee on Benefits and Costs, 1950), and a Budget Circular produced two years later finally began to merge the practice of cost-benefit analysis with the theory of welfare economics (Dasgupta and Pearce, 1972, p. 12). However, these early documents still stressed economic welfare rather than social welfare. They "talked of social gains in terms of the national product, ignoring the fact that some social gains and losses are not expressible in terms of recorded national product, and that governments might have aims other than maximising gains to the national product" (Dasgupta and Pearce, 1972, p. 12).

In the late 1950's three articles by Eckstein (1958), McKean (1958) and Krutilla and Eckstein (1958) outlined clearer links between cost-benefit analysis and welfare economics. The theory of welfare economics changed cost-benefit analysis in two ways. First, it stressed that governments could have a range of socio-economic and political objectives in addition to that of economic efficiency (e.g., Little, 1957). Social welfare was therefore not necessarily synonymous with economic welfare, and cost-benefit analysis, if attempting to guage national welfare, would have to consider other potential objectives. Otherwise, cost-benefit analysis could only comment on the economic efficiency of projects, leaving the analysis, of other considerations to decision-makers. Second, the theory of welfare economics helped to more clearly define categories of ***social costs*** and benefits (Pearce, 1983, p. 16). There was now a clearer conceptual basis for supplementing economic costs and benefits with a notion of externalities, costs and benefits not reflected in market transactions but which "alter the physical production possibilities of other producers or the satisfactions that consumers can get from given resources" (McKean, 1958, p. 136). Externalities might include such effects as pollution or changes in scenic or recreational resources. The terms ***social cost-benefit analysis*** and cost-benefit analysis are now used interchangeably.

It is important to understand what social cost-benefit analysis was saying at the end of the 1950's. Krutilla and Eckstein (1958) understood that income redistribution might be an objective of governments, but economic analysis could not give an objective answer if redistribution were included in an analysis because economists could not make the value judgments required to determine which groups or regions should be favored. They could, however, trace out the distributional implications of a project by noting the amounts of economic efficiency, or aggregate consumption, costs and benefits received by various regions. Similarly, McKean (1958) did not consider income redistribution as a separate objective but did trace out the distributional implications of economic efficiency. However, McKean stated that when distributional effects were considered to be important, the results of a cost-benefit analysis could not be the final word on a project's desirability -- the analysis could only comment objectively on efficiency aspects. Within this economic efficiency perspective, McKean (1958) defined a wide variety of externalities related to water resource developments that could affect economic efficiency, such as pollution and changes in agricultural productivity, in scenic resources and in recreational resources (pp. 135-6). According to McKean, when externalities exist

> The implications for cost-benefit analysis are fairly clear. The measurements should allow for major external effects of the technological variety -- that is, the variety which alters the physical production possibilities of other producers or the satisfactions that consumers can get from given resources (p. 136).

Moreover, McKean recommended that when intangibles could not be quantified and when uncertainty was present, the analysis should include separate exhibits on these aspects for the consideration of the decision-maker.

Cost-benefit analysis began to be used in Canada in the late 1950's and early 1960's largely in the area of flood control. The ***Resources for Tomorrow*** conference held in Montreal in 1961 produced a ***Guide to Benefit-Cost Analysis*** (Sewell et al., 1965), subsequently published by the Canadian government in 1965. The ***Guide*** described cost- benefit analysis from an economic-efficiency perspective, mentioning neither the possibility of incorporating other objectives nor the possibility of identifying the regional distribution of efficiency costs and benefits. However, the ***Guide*** did stress the identification of social costs and benefits, including external effects such as changes in scenic resources, the benefit of preserving land in its natural state, the loss of a sport fishery, pollution, and the destruction of wildlife habitat (Sewell et al., 1965, pp. 6, 10). Moreover, the Guide recommended a progressive approach for dealing with externalities or intangibles that might be difficult to quantify. By producing a qualitative statement of effects, unquantified externalities could be thought of as

> . preponderantly positive or negative factors. Thus, the analyst is 'forced to regard the benefit-cost ratios of tangibles . to be modified by the value of intangibles. ... Treated in .this way they can, at times, tip the balance away from one alternative and result in the selection of another (p. 6).

So, at the beginning of the 1960's, social cost-benefit analysis represented a technique for evaluating projects in terms of their contribution to economic welfare and provided a framework for incorporating externalities, both quantitative and qualitative, and for identifying the distribution of efficiency gains and losses whether by region or by income group.

During the 1960's a debate emerged about the proper role of economic analysis. Economists recognized that governments might have multiple objectives, but that to include objectives other than economic efficiency would require political input. Many economists therefore chose to focus on the economic efficiency of projects on which they claimed they could make fairly "objective" evaluations, recognizing at the same time that their analyses would provide only partial answers if other social objectives existed. Other economists (e.g., Lipsey and Lancaster, 1957) questioned the ability of cost-benefit analyses to make any statement at all about the economic efficiency of projects because the assumptions underlying welfare economics appeared invalid (see Chapters 3 and 4 for a detailed discussion). Economists working in developing countries, such as Marglin (1967), as well as planners, primarily Lichfield (1966c) and Hill (1967), wished to more explicitly incorporate multiple objectives in a cost-benefit framework.

Marglin (1967) recognized the existence of social objectives such as income redistribution, employment and national self-sufficiency and specified how costs and benefits were to be defined for each of these objectives within a social cost-benefit framework This work was developed further in a collaborative effort by Dasgupta, Sen and Marglin in 1972 for the United Nations. At about the same time as Marglin's earlier work (1967). the Planning Balance Sheet was developed in England by Nathaniel Lichfield (1966c, 1969), also in response to CBA's frequent neglect of non-economic social objectives. Lichfield was primarily concerned with promoting the use of both economic efficiency and income redistribution as separate components of social welfare, leaving the task of weighting the relative importance of the two objectives to decision-makers. Lichfield also stressed the importance of identifying those externalities which would not be quantitatively evaluated. P.B.S., as construed by Lichfield, was not a new technique but rather a more explicit statement of one possible formulation of social cost-benefit analysis (with income redistribution as an objective) and a restatement of the proper way to conduct cost-benefit analysis in the light of intangible effects (Lichfield et al., 1975, p. 78).

Shortly after Lichfield's work on P.B.S., Morris Hill developed the Goals Achievement Matrix which he touted as a more "rational" method of evaluation than either P.B.S. or cost-benefit analysis (Hill, 1967, 1973). in the G.A.M. framework, an analyst is required to calculate costs and benefits according to *community objectives,* which need not include either economic efficiency or income redistribution. Hill claims that G.A.M. is more rational than P.B.S. or C.B.A. because it does not presume that efficiency and distribution are the sole objectives of a community; in effect, all Hill is saying is that a cost-benefit analysis should be based on some conception of social welfare. Welfare economists had been saying that for quite some time, and the work by Marglin (1967) and Dasgupta, Sen and Marglin (1972) gave an analyst better guidelines as to how to proceed with this type of multi-objective analysis. Nevertheless, Hill's work did help to translate the concepts of cost-benefit analysis into the field of community and regional planning.

While Hill and Lichfield's efforts only reproduced cost-benefit analysis under another name, their methods, particularly P.B.S., do stand as attempts to improve practical applications of cost-benefit analysis by focussing more attention on distributional consequences and on broader interpretations of social welfare. The use of these techniques appears, however, to have been restricted to the United Kingdom (see, for example, Lichfield, 1966b, 1966c, 1969).

The two developments in the theory of social cost-benefit analysis -- the definition of social costs and benefits (including externalities) and the recognition of multiple objectives -- were slow to be adopted in practice. Cost-benefit analyses continued in many cases to be concerned only with economic welfare and gave little attention to environmental and social impacts that might affect economic welfare. It was the neglect of environmental and social impacts which drew the most attention in the 1970's. In the 1970's the environmental and social impacts of projects began to receive more widespread attention in both the United States and Canada. Several factors prevalent during this decade contributed to this new focus. Firstly, the increased scale and variety of government projects drew attention to major environmental and social consequences (Rees, 1985; O'Riordan and Sewell, 1981). Secondly, the increased protest by environmental lobby groups made environmental quality objectives and social objectives more politically significant (Rees, 1985; O'Riordan and Sewell, 1981). Thirdly, high levels of economic growth in the 1970's and consequent expectations of sustained long-term growth made environmental and social goals more ***affordable*** (see Schramm, 1973; Rees, 1985).

As a result of these forces, the early 1970's saw the development of something called environmental impact assessment **(E.I.A.)** which stressed the analysis of environmental and social impacts. This development was in response to the past failure of cost-benefit analysts to incorporate environmental and social impacts in their analyses As Dasgupta and Pearce noted in 1972, "there is also frequently little or no relationship between practical applications [of **CBA]** and the welfare theory which, one supposes, should underlie the practice" (1972, p. 14). It would appear that social cost-benefit analysis had not been widely adopted in the 1960's despite the advances made in identifying and evaluating environmental and social impacts.

Cost-benefit analysis suffered a decline in popularity in the **1970's** because it was not well understood by practitioners and was mistrusted by theorists. Practitioners and the public had a poor image of CBA because many analyses being conducted at that time considered only economic costs and benefits. When environmental and social impacts were identified, doubts about the ability of social cost-benefit analysis to ***evaluate*** them developed because the evaluation relied on dollars as a measuring unit; somehow it was felt that this was an inappropriate measure for valuing non-economic impacts (Pearce, 1983, pp. 18-9) (see Chapter 4.1 for a detailed discussion of methodological problems in evaluation). This is the dilemma of cost-benefit analysis:

> It is precisely because cost-benefit analysts have either ignored these problems, or because they have made bold attempts to value such gains and losses (and boldness is not **necessarily** a virtue here), that many people have become disenchanted with the procedure. To omit certain gains and losses is to fail to meet the all-encompassing definition of social costs and benefits. To include them is to stand charged with "arbitrariness" or valuing that which cannot be valued (Dasgupta and Pearce, 1972, p. 14).

At the same time that cost-benefit analysis was losing its general appeal, critics stressed the pervasiveness of value judgments embedded in cost-benefit analysis (see, e.g., Nash et al., 1975). Soon cost-benefit analysis was perceived to be not "objective" enough (see

Chapter 4.2 for a detailed discussion).

These misgivings about the appropriateness of cost-benefit analysis paved the way for the development of environmental impact assessment in government. A developing awareness of the inability of existing government departments and agencies to manage environmental and social impacts, and concerns over agency bias, mandated some type of administrative-structure changes to specifically require consideration of such impacts (O'Riordan and Sewell, 1981; Rees, 1985). In the early 1970's the U.S. enacted the ***NEPA*** and environmental impact assessment soon came to be regarded as something distinct from cost-benefit analysis. The NEPA required government agencies to consider the economic, social and environmental consequences of public projects and produce an Environmental Impact Statement. While the Environmental Impact Statement requirement certainly improved the presentation of data for decision-makers by identifying the environmental and social impacts of projects, its effectiveness has been criticized as it often only "added a new procedure which had to be undertaken before formal decisions were made, [but] did not significantly alter the decision system pet se" (Rees, 1985, p. 326). Environmental impact assessment in the United States developed largely as ***inventories*** of physical effects rather than as ***evaluations*** of effects (Rees, 1985).

As environmental impact assessment developed in the U.S. and Canada during the 1970's and 1980's it began to have a wider definition. There has been an increasing emphasis on the integration of economic, environmental and social impact identification and evaluation. Environmental impact assessment now claims to be "an activity designed to identify and predict the impact on the biogeophysical environment and on man's health and well-being of legislative proposals, policies, programmes, projects, and operational procedures, and to interpret and communicate information about the impacts" (Munn, 1979, p. 1). Or more simply, environmental impact assessment is "a process designed to select alternatives, devise policies or suggest mitigation measures that ***maximize social welfare"*** [emphasis added] (Hyman et al., 1980, p. 210).

From this definition it appears that environmental impact assessment and cost-benefit analysis are now synonymous. In many respects they are. Environmental impact assessment represents the maturing of the practical use of cost-benefit analysis. Yet there are two distinct bodies of literature, the economic literature of cost-benefit analysis and the planning literature of environmental impact assessment,

Both cost-benefit analysis and environmental impact assessment are rooted in the rational comprehensive model of decisionmaking (Hollick, 1981; Wierzbicki, 1983). They are ***rational*** because they follow a systematic and logical procedure, and comprehensive because they require the consideration of all alternatives and consequences (Hollick, 1981, p. 81). There are five basic components, or tasks, of a rational decision model (see, e.g.: Bradley, 1973, p. 290; Coleman, 1977, p. 37; Hollick, 1981, p. 81; Lindblom, 1965, pp. 137-8; Cyert et al., 1956);

1. the recognition of a problem;
2. the definition of goals and objectives;
3. the identification of all feasible alternatives to achieve the goals;
4. the identification of all consequences of each alternative; and
5. the evaluation of the consequences and the selection of that alternative most conducive to the pre-selected goals.

Cost-benefit analysis is often associated with this final task of ***evaluation.*** However,

> . . . social benefit-cost analysis is not a technique but an approach. It provides a rational framework for project choice using national objectives and values (Dasgupta, Sen and Marglin, 1972, p. 14).

McKean (1958) recognized early in the development of cost-benefit analysis that the definition of objectives, alternatives and consequences (or impacts) was an important component of cost-benefit analysis. However, these tasks are frequently glossed over or altogether neglected in cost-benefit guidelines and in the theory of welfare economics There are two possible explanations for this emphasis on evaluation. First of all, the contribution that economists can make to cost-benefit analysis is in the identification of economic impacts and in the evaluation of all types of impacts, whether economic, environmental or social. The definition of goals, objectives and alternatives, and the identification of environmental and social impacts is a multi- disciplinary and political process in which economists have no particular expertise. Secondly, cost-benefit analysis was initially developed for project justification by government budget authorities, and not for project planning by the government agencies in charge of selecting and implementing projects (see Marglin, 1967, p. 18; Downs and Larkey, 1985, p. 114).

In contrast, environmental impact assessment is more closely associated with project planning than with justification, giving more attention to problem formulation, the definition of goals, objectives and alternatives, and the prediction of impacts. Environmental impact assessment also deals with the way information can be gathered, how institutional structures for conducting analyses can be designed, and how project impacts can be managed. Less attention is given to specific evaluation techniques, but evaluation is clearly part of environmental impact assessment.

As a result of this different emphasis, the literatures of cost-benefit analysis and of environmental impact assessment have diverged. The cost-benefit literature focuses on evaluation techniques while the impact assessment literature has more to say about processes for conducting impact assessments and managing project impacts. Increasingly, environmental impact assessment has paid more attention to linking the project-specific focus of CBA and EIA to broader planning concepts (which ask not what is the best use of funds but what is the best use of society's environmental resources) by encouraging the development and coordination of regional resource policies, goals and priorities (see, for example, Cornford et al., undated; Marshall et al., 1985; Sadler, undated; O'Riordan and

Sewell 1981).

3.0 WHERE ANALYSES DIFFER I

The previous chapter identified the five basic tasks involved in a cost-benefit analysis. These are:

1. the recognition of a problem;
2. the definition of goals and objectives;
3. the identification of all feasible alternatives;
4. the identification of the consequences of each alternative; and
5. the evaluation of consequences and alternatives, and the selection of the best alternative.

The problem which this thesis addresses is to discover why this one decision model can produce competing analyses. To that end, this chapter looks at the first four tasks of this rational comprehensive decision model to determine how different analyses might arise. Chapter 4 then addresses sources of competing analyses in the fifth task of analysis, the evaluation of alternatives.

3.1 PROBLEM FORMULATION AND EVALUATION

The nature of problem formulation is this:

> For an analysis to take place, someone must have or anticipate a problem, that is, must be dissatisfied with some aspect of the current or projected state of affairs and want to consider a decision in terms of altering it (Quade, 1975, p. 49).

The way a problem is defined affects all other stages of the decision process - what objectives will apply, what alternative solutions are possible, what impacts are likely to occur, and what evaluation will yield. Defining a problem involves specifying "where you are now and where you want to be" (Downs and Larkey, 1986, p. 131), or alternatively, where you don't want to be in the future. It also involves identifying the constraints that apply to a proposed solution: how much it can cost, how quickly it must be implemented, as well as ethical, legal and technological constraints (Quade, 1975, p. 35; Hollick, 198 1).

What can we say about public policy problems in general? Quade (1975, p. 8) calls them “messy and ill-defined” and suggests that they are “wicked problems” (see also Mason and Mitroff, 1981, p. 9). A wicked problem has two characteristics: it is complex and that complexity is organized. The complexity of public policy problems means that a problem is actually composed of many problems and issues which are interrelated and difficult to isolate (Mason and Mitroff, 1981, pp. 4-5). Because this complexity is organized, it affects the types of analysis which can be used Modelling -- exploring the structural relationships among system components -- becomes crucial. Statistical methods suitable for problems with “many individual elements exhibiting independent, probabilistic behavior" are less reliable when applied to problems with many interrelated and inseparable components (Mason and Mitroff, 1981, p. 6). Wicked problems are also difficult to define, and they may be defined differently depending on who it is that is trying to define the problem: many public policy problems are therefore ambiguous. The definition of a problem may also change over time as new aspects become evident (Quade, 1975, p. 49).

The types of public policy problems which arise in impact assessment are only a small subset of the vast array of problems that governments face in day-to-day decision-making. As the history of project evaluation has shown it has typically been only large-scale projects which are required to undergo a rational comprehensive type of analysis, and it is usually only those large projects likely to have major environmental and social effects that will be evaluated The evaluation of policies is much less frequent, and a linkage between project evaluation and regional planning is even more rare.

The problems which fall under the purvue of impact assessment and cost-benefit analysis are frequently defined by the agency responsible for project construction. But the definition of the problem is affected not only by an agency’s perception but *by the* **rde** ***that*** *impact assessment* ***plays.*** *Because* impact assessment is used primarily for project justification rather than for project planning, problems tend to be defined in one of two ways:

1. Should a particular project be built?
2. Which of several facilities within an agency's mandate should be built?

Downs and Larkey (1986, p. 119) comment that the first type of problem definition is the most common in cost-benefit analysis. Problems are not defined in a broad context in which the one or few proposed projects are only a small subset of solutions to a much larger problem. In other words, problems are not necessarily formulated to optimize the activities of an agency; they are formulated only to ensure some minimum requirement of acceptable activity.

This point is important to stress because the theory of welfare economics usually tries to make a statement about optimal resource allocations in society. And it is limited to statements about marginal projects in society, unlike the inherently elusive field of planning which attempts to grapple with non-marginal issues such as the best combined use of all resources in a region. The way a problem is defined will affect whether cost-benefit analysis can state that a project should be undertaken or if it can only state that social welfare will not decrease because a project is undertaken. If a problem is defined to be whether or not one particular project should be built,

> Where the single public project that is analyzed comes from is never clear. Why that project and not others? Most public projects probably begin as a gleam in the eye of a citizen or politician who sees potential benefits or in the eye of an engineer in the Army Corps of Engineers who sees a potentially interesting solution to a flooding, irrigation, or water supply problem There is no persuasive theory of "the optimality of gleams" (Downs and Larkey, 1986, p. 119).

In summary, perceptions and definitions of problems have important implications for the remaining steps in analysis. Different people may define problems differently and apply different constraints. The differences may be the result of inaccurate perceptions or of accurate but fundamentally different ones based on moral values and beliefs. Problems which are dynamic and difficult to define also complicate this first task in analysis. So, while it may be possible to sometimes say that someone's problem definition is wrong, oftentimes it will only be possible to say that their problem definition is ***different***.

3.2 OBJECTIVES AND EVALUATION

Objectives provide the criteria by which projects are evaluated. In the words of Winch (1971, p. 15), "One cannot assess the appropriateness of a particular policy, nor choose among alternative policies, unless one pays attention both to the probable consequences of those policies and the objectives that are sought" Impacts are defined as movements toward or away from these specified objectives -- they are the consequences resulting from projects. Costs and benefits, in turn, measure the relative value of those impacts.

A cost-benefit analysis could be done from a variety of perspectives. For example, an analysis could be done from the point of view of one particular individual affected by a project using his or her personal objectives, such as maximizing income or acting in accordance with certain religious principles. Alternatively, an analysis might be done according to the objectives of decision-makers, which might include the objective of staying in power or maximizing the size of his or her budget and personnel. However, the theory of welfare economics says that a social cost-benefit analysis should focus on ***social welfare,*** the general welfare of ***all*** individuals in society (Krutilla, 1961). Just what exactly constitutes social welfare is as difficult to determine as defining the public interest. Possible determinants of improved social welfare include higher consumption (the efficiency objective), a better distribution of income (the equity or redistribution objective), employment opportunities, national prestige or self-sufficiency, or the production of desirable goods or services (generally, see Marglin, 1967; Dasgupta, Sen and Marglin, 1972; Henderson, 1970; Heaver, 1973).

In order for these objectives to provide useful guidelines for analysis, each objective must be defined operationally. For example, economic efficiency can be translated into "increasing the country's GNP." The income redistribution objective must specify what redistribution goals are sought, perhaps according to income levels or regions. Similarly, environmental quality must be translated into more specific objectives such as certain levels of air quality, water quality, or acceptable concentrations of toxic substances, for example. In addition, the relative importance of one objective versus another must be determined if some measure of the overall desirability of each alternative is desired.

How is an analyst to decide which objective(s) should be used? Welfare economics only says that society's objectives should be used but does not tell how these objectives can be identified. The use of different objectives may result is radically different analyses. While no one objective is inherently better than another, the techniques for dealing with some are better developed than for others. This chapter examines several common objectives and the theory developed to support them

3.2.1 The Efficiency Objective

The economic efficiency objective is the one most commonly used in cost-benefit analysis, almost to the exclusion of all other possible objectives. While techniques have been developed to incorporate mul tiple objectives in SCBA (e.g. Marglin, 1967; Dasgupta, Sen and Marglin, 1972; Lichfield et al., 1975), they are rarely adopted in practice. This emphasis on the economic efficiency objective perhaps stems from the development of cost-benefit analysis as a device for encouraging some measure of efficiency in government decision-making, either to enhance or supplant political decision-making processes (Downs and Larkey, 1986, p. 108). Arguments to support the use of economic efficiency as the sole basis for public-sector project evaluation include the notions that (i) the efficiency of government decisions should act as a counter- balance to the non-efficiency bias of politicians (Dasgupta and Pearce, 1972, p. 67). or (ii) economic efficiency is the only component of the social welfare function -- multiple objectives do not exist As Tribe (1976) notes, analytic tools which focus on one objective, such as economic efficiency, can be very powerful; but they are subject to limitations as well. The theory of welfare economics reveals several weak points in the underlying structure of social cost-benefit analysis which cast doubt upon the ability of such an analysis to make any conclusive statement at all about the economic efficiency of projects.

The welfare economics theory applying to cost-benefit analysis looks at changes in individual welfare, or consumer's surplus, that result from proposed projects or policies. Use of the economic efficiency objective assumes that changes in an individual's level of consumption are an adequate measure of changes in welfare. If this is so, then a variety of decision rules could be applied to these individual changes in order to choose among projects. Possible decision rules include: only selecting projects which do not decrease any one person's welfare, called the Pareto rule; or the potential Pareto, or Hicks-Kaldor, rule, by which a project is undertaken if the sum of welfare changes for those who benefit from a project is greater than the sum of welfare changes for those whose welfare decreases. As discussed in Chapter 4.2, the selection of a decision rule is ultimately an ethical choice (see Nash et al., 1975; Treasury Board Canada, 1976, p. 40).

Cost-benefit analysis adopts the Hicks- Kaldor rule which says that a project would be undertaken if project costs are greater than benefits and if those who receive benefits *could* compensate those who suffer costs. There is no requirement in the Hicks- Kaldor rule that compensation actually take place (Pearce, 1976). In order for this decision rule to lead to an increase in economic welfare as defined by an increase in aggregate consumption, several conditions must hold:

1. that prices equal marginal cost in all sectors of the economy;
2. that the income distribution is optimal, or ideal; and
3. that the project effects do not alter the existing distribution of income (see Krutilla, 1961, p. 227).

How likely is it that these three conditions will hold, such that Hicks-Kaldor rule will actually lead to an increase in economic welfare? Firstly, all prices equal marginal cost only in a perfectly competitive economy. In reality, there are often violations of this rule, such as imperfect factor and product markets, economies of scale, or divergences between marginal private cost and marginal social cost. When prices do not equal marginal cost, a "first best" world does not exist and the state of "second best" arises (in general, see Lipsey and Lancaster, 1957). The theory of second best states that if all prices do not equal marginal cost there is no theoretical proof that projects adopting the Hicks- Kaldor rule will actually result in an improvement in economic welfare (see also Krutilla, 1967; Winch, 1971). The second-best theory therefore implies that the existence of total project benefits in excess of total costs may not guarantee an improvement in economic welfare. This problem of second best is the source of the controversy over the usefulness of estimating shadow prices to reflect social costs and benefits. If shadow prices are not used in all sectors of the economy, there is no guarantee that their use in the public sector alone will result in an increase in economic welfare.

The second condition which must hold for the Hicks- Kaldor test to lead to an increase in economic welfare is that the existing distribution of income must be seen as optimal. Optimality means that society would not feel better off by changing the existing distribution of income in any way because "people 'deserve' rewards equal to their contribution [to society], and hence the distribution of income is good" (Nash et al., 1975, p. 126). Implicitly, cost-benefit analysis accepts the existing distribution of income as optimal by its reliance on market prices, which are determined by the distribution of income (the social welfare function applies to only one distribution of income) (Foster, 1966).

Krutilla (1961) and Foster (1966) summarize several arguments that could support the acceptance of the existing distribution as optimal. First, because a democratic community has the means to change the income distribution, the observed distribution must be the optimal one (Krutilla, 1961; Foster, 1966). Second, the income distribution may not be optimal, but because the costs of redistribution would prove to be greater than the benefits provided by redistribution, some inequity is tolerated (Krutilla, 1961). A third argument claims that redistribution might be more effectively achieved through direct means such as transfers and subsidies (Foster, 1966; see also Henderson, 1970, p. 287), and therefore concerns about distribution should not affect project selection And finally, the redistributive effects of a project may be trivial (Foster, 1966) or cancel out across a number of projects (Dasgupta and Pearce, 1972, p. 92). But as Krutilla notes, in this final argument "this does not mean that benefit-cost analysis is free of distributional value judgments" (1961, p. 229). as it still accepts price data based on the existing distribution of income. These arguments are not evidence but musings on the possibility that the income distribution is optimal or that concerns about income distribution should not affect project evaluation. According to Foster, the first argument is the strongest because "One can only counter by flat denial that the existing distribution of income is generally agreed to be the best possible, or by producing evidence that this is not in fact a concensus or even a majority view" (1966, p. 310).

But what if analysis proceeds when the income distribution is not optimal? According to Krutilla (1961), if the original distribution is not optimal, use of the efficiency objective alone will not guarantee an increase in economic welfare. Changes in consumer's surplus cannot be measured directly by market. prices because people's deservingness differ from their incomes. Market prices can, however, be weighted in some way to reflect a more preferred income distribution. This will be discussed further in Section 3.2.

Whether or not the existing distribution is optimal seems a moot point, And the validity of ignoring redistribution as an objective turns on (i) how optimal the current distribution is, and (ii) if it is not optimal, how effective are more direct methods of income redistribution (Henderson, 1970, p. 288).

Turning now to the third condition which must hold for the Hicks-Kaldor test to lead to an increase in economic welfare -- that the distribution must be the same both before and after the project is implemented -- two additional difficulties arise. First, if the project changes the distribution of income, then economic welfare is maximized only if compensation actually takes place (Krutilla, 1961). Second, if a project changes the existing distribution of income, and hence the relative prices of goods and services in the economy, then it may be possible that "we can hypothesise a project involving a move back to the initial position and this project may be sanctioned by the very same test used to justify the move away from that initial position" (Pearce, 1983, p. 17). This is known as the ***Scitovsky reversal paradox,*** in which Policy X may be abandoned at time t= 0 in favor of Policy Y based on their respective benefit-cost ratios; but when both policies are re-evaluated at time t= 1 (after Policy Y has been implemented), the analysis suggests abandonment of Policy Y in favor of the old Policy X.

As a final point with respect to pursuing economic efficiency as an objective, Henderson (1970) notes that externalities must be included in cost and benefit calculations (see also Gramlich, 1981, p. 20). If the production of externalities is a necessary condition for the production of some marketed output, then

> . . the likelihood that these effects will be generated, and their prospective strength and influence, have to be taken into account in any sensible calculation of the net efficiency benefits of a project (p. 281).

Analyses which fail to include externalities would therefore be misstating welfare effects. If externalities are difficult to quantify (see Chapter 4.1.1), then it may not be possible to produce summary cost-benefit ratios.

3.2.2 The **Efficiency Objective and Income Distribution Weights**

In a social cost-benefit analysis, the economic efficiency costs and benefits may be broken down according to various groups or regions on which they fall. This may be done for illustration purposes only, or weights may be attached to different regions or groups and the cost and benefit streams adjusted accordingly. Use of income distribution weights implies that project costs and benefits are distributed in such a way as to alter an existing optimal distribution (Dasgupta and Pearce, 1972, p. 62). and that more direct methods of redistribution may incur a loss of efficiency or be considered demeaning to citizens and, as a result, project selection should also be used as a means of redistributing income.

The weighting of **efficiency** costs and benefits is achieved by analyzing the net efficiency costs and benefits, determining to whom they accrue, and applying weights to changes in consumption for various groups, regions, or any aggregation of individuals with similar utility weights (see, e.g., **Krutilla,** 1961; Henderson, 1970). Various weighting procedures have been proposed, but there is no consensus in the literature as to which method to adopt. Four possible weighting procedures include:

1. assigning weights based on the marginal utilities of income of all individuals;
2. assuming that the poor have higher marginal utilities of income;
3. combining **#** 1 or **#2** above with a concept of the deservingness of certain groups; or
4. assessing deservingness alone (generally, see Henderson, 1970; Dasgupta and Pearce, **1972;** Pearce, 1976).

Assigning weights based on an individual's marginal utility of income would require (i) identifying the ***specific*** individuals affected by a project and (ii) measuring each individual's income utility. The problems with this approach are that it would require costs and benefits to be broken down to a level of detail not easily obtained, if at all; and even if it were possible to identify all affected individuals, there is no clear theoretical method for measuring income utility (Henderson, 1970). Because of this **difficulty,** economists often focus on the ***assumption*** that the poor have higher marginal utilities of income and then develop methods for reflecting this assumption. Foster **(1966),** for example, suggests weighting costs and benefits by the ratio of mean population income to an individual's income. Another common method is to rely on marginal tax rates which are lower for low-income individuals. For example, Nwaneri (1970) derived a variety of weights used to scale down costs and benefits to project beneficiaries, leaving costs to sufferers unchanged. His weights reflect: the marginal tax rate; the marginal tax rate and the size of the community; the marginal tax rate, size of community and house price depreciation; the marginal tax rate and degree of community disruption; and differences in estimated marginal utilities of income. Deservingness is based on some social judgment about equity, such that deservingness weights would be ultimately decided by some political means or social consensus Or these weights might be based on an analysis of weights implicit in past policy decisions.

The inclusion of equity weights in SCBA based on income utility is a relatively contentious procedure. For example, Pearce and Wise (1972) criticized Nwaneri's methods as they doubted "the extent to which adjustments for income utilities have anything to do with value judgments concerning equity" (p. 324). In other words, calculating income utilities directly or assuming that the poor have higher marginal utilities of income does not imply that the resulting weights would ***necessarily*** reflect society's notions of an ideal or more equitable distribution of income. While there is no acceptable theoretical method for determining utility weights and their usefulness may be questioned, there may also be considerable political risk for decision-makers in applying utility weights or expressing deservingness weights (Henderson, 1970). Ultimately, the selection and specification of utility and/or deservingness weights is an ethical choice.

The use of income distribution weights, however derived, is also criticized because of the effect they have on the economic efficiency objective. As Pearce (1976, p. 11) notes, adopting weighting rules "abandon[s] Pareto optimality as an objective" (p. 11) and jeopardizes the achievement of the efficiency objective (Winch, 1971, p. 99). Thus, the use of income distribution weights might deem uneconomical projects to be acceptable.

3.2.3 The Efficiency Objective and the Redistribution Objective

Income redistribution is pursued as a separate objective (rather than incorporated in an analysis as weights) if the distribution existing at the time of the analysis is not the desired one and if redistribution is deemed to be an important function of project selection. According to Henderson (1970),

> "If account is to be taken of distribution effects, especially those between regions, then benefits have to be conceived in much wider terms than is the case when efficiency aspects alone are under consideration. It is not a matter of looking merely at the net efficiency benefits, and trying to determine to whom these are likely to accrue" (p. 289).

If income redistribution is deemed to be a component of social welfare, then an additional category of costs and benefits would be added to the analysis, in which redistribution costs and benefits would be measured as movements toward or away from a specified income redistribution goal. Any income distribution could be defined as the desired distribution.

The incorporation of efficiency and redistribution (or equity) in a social welfare function is based on the assumption that consumption alone does not have independent value, but rather that the *utility* derived from consumption has independent value (Henderson, 1970). This utility is assumed to be derived from both the level and ***distribution*** of consumption (Lichfield, 1966a, p. 342), and hence both economic efficiency and income redistribution are treated as separate objectives. Henderson (1970) argues that if all individuals in a society had the same marginal utilities for changes in consumption, then maximizing consumption alone (the economic efficiency objective) would be equivalent to maximizing the utility of consumption. Because of the difficulty in objectively determining consumption utilities, it becomes a matter of judgment whether or not marginal utilities are likely to be the same for all individuals. The use of the income redistribution objective also means that equity weights do not need to be attached to the costs and benefits related to economic efficiency. Lichfield suggests that any costs to individuals which remain uncompensated could be weighted to increase their significance in the analysis (1975, p. 93).

3.2.4 Multiple Objectives

Marglin (1967) and Dasgupta, Sen and Marglin (1972) explain how analysis might take into account objectives such as increased employment, national self-sufficiency and the production of merit goods. Because these objectives are rarely considered in developed economies, the reader is referred to these sources for a detailed treatment.

3.2.5 Determining the Social Welfare Function

It has hopefully become apparent from the preceding analysis that the selection of objectives in cost- benefit analysis rests upon a value judgment concerning what social welfare is or is likely to be, or upon the aims of analysis -- to maximize some broad conception of social welfare or merely to guage government efficiency -- and that different analyses are produced by using different objectives.

As we have seen from the previous discussions of welfare economics, techniques for measuring economic welfare are fairly well-developed and are more common than attempts to measure other components of social welfare. Little (1957) recognized almost thirty years ago that there is a tendency in evaluation to confuse ***social*** welfare with ***economic*** welfare. Economic welfare is only one component of a social welfare function; if it is not the only component, there is no reason to assume that the results of evaluations are making valid claims about improved ***social*** welfare. The use of welfare economics involves making ethical assumptions as well as assumptions about components of social welfare, but this is rarely recognized in practical applications. Little's comments about the abuse of welfare economics are worth repeating at length here.

> The truth of the contention that welfare conclusions are value judgements is borne out by the ease with which welfare economists slip from talking about economic welfare into using a frankly ethical terminology ...
>
> First, the word "economic" usually gets left out. This greatly increases the emotive effect. If I say "this change will increase economic welfare", it is open to anyone to say "perhaps, but it will not increase political welfare, or welfare in general". This reply is not open if I leave out the world "economic".

> Putting it in always suggests that the economist's conclusion is not the last word, and that, therefore, the conclusion is not to be taken as a definite recommendation.
>
> Secondly, the word "social", or "community", or "national" is often inserted where "economic" is left out. This also increases the persuasive effect, for all these words are highly emotive to different classes of people. Thirdly, instead of "increase of economic welfare" we very often find the word "benefit". "Benefit" is obviously an ethical word. "Social benefit" and "social advantage" have also been used (1957, p.).

If we cannot be certain that economic welfare is an adequate measure of social welfare, then a social welfare function must somehow be defined. Kenneth Arrow (1951, 1963) addressed the challenge of constructing a social welfare function in his book, ***Social Choice and Individual Values. Arrow*** defined five conditions or rules which would define an acceptable process for amalgamating individual preferences to produce a ranking of social preferences. These are:

Condition 1: "the social welfare function is defined for every admissible pair of individual orderings" (1983, p. 15), or, in other words, this conditions requires that the social welfare function "give rise to a true social ordering" (1983, p. 15).

Condition 2: ***Ptasitive Association of Social and Individual Values,*** which says that "the ***social*** welfare function does not reflect individuals' desires negatively" (1983, p. 24).

Condition 3: ***Independence of Irrelevant Alternatives,*** which says that "the choice between [two alternatives] x and y is determined solely by the preferences of the members of the community as between x and y" (1983, p. 17). This implies that "all methods of social choice are of the type of voting" (1963, pp. 27-8).

Condition 4: ***The Condition of Citizens' Sovereignty,*** which requires that "the social welfare function is not to be imposed" (1983, p. 18), whether by religious, ethical or otherwise traditional societal **norms,**

Condition 5: The ***Condition of Nondictatorship,*** which requires that "the social welfare function is not to be dictatorial" (1983, p. 19), so that a social welfare function could not be defined by the will of one particular person.

In addition to these five conditions, Arrow defines two axioms which describe rationality in the context of choice between alternatives. Axiom I says that "for any pair of alternatives x and y, either x is preferred to y or y to x, or the two are indifferent" (1963, p. 13). Axiom II states that "if x is preferred or indifferent to y and y is preferred or indifferent to z, then x must be either preferred or indifferent to z" (1963, p. 13).

Based on these five conditions and two axioms, Arrow derives two theorems which have astounding implications for the possibility of constructing a social welfare function. Theorem I, or the ***Possibility Theurem for Two Alternatives,*** predicts that when there are ***two*** alternatives, a decision reached through majority voting will produce a social welfare function. which satisfies "Conditions 2-5 and yields a social ordering of the two alternatives for every set of individual orderings" (1963, p. 48). But this result does ***nut*** extend to a situation in which there are ***more than two*** alternatives. Arrow's ***General Possibility Thewem says*** that:

> If there are at least three alternatives which the members of society are free to order in any way, ***then every social welfare function satisfying Conditions 2 and 3 and yielding a social ordering satisfying Axioms I and II must be either imposed or dictatorial*** [emphasis added] (1963, p. 59).

The implications of the General Possibility Theorem are clear: that majority voting is incapable of producing a social welfare function which meets the five conditions outlined earlier.

Arrow has additionally shown, in his ***Impossibility Thewem,*** that ***all*** methods to produce a social welfare function, and not just majority voting, are incapable of "simultaneously satisfying the conditions of Collective Rationality [condition 1], the Pareto Principle [condition 2], the Independence of Irrelevant Alternatives, and Nondictatorship" (1983, p. ***72). In*** other words, there is no theory of social choice from which **a social** welfare function can be derived. Dasgupta and Pearce (1972) summarize the implication of this dilemma for social cost-benefit analysis:

> If effect, Arrow's theorem states that there exists no method for determining the social ranking of alternative social states which is both based on individual preferences and satisfied some intuitively plausible criteria of "reasonableness" for social choice. The links between collective rationality and individual preferences are thus severed. Hence, Arrow's work has damaging consequences for the theory of welfare economics which has traditionally been regarded as providing precisely such a link. And if this link does not exist for welfare economics, it does not exist for cost-benefit analysis, which is based upon welfare economics (p. 80).

Some critics have attempted to refute Arrow's theorem by refuting his methodology or some of his conditions. According to Dasgupta and Pearce (1972), however, "the only possible escapes ... foundered upon serious obstacles" (p. 94). If a social welfare function could be defined, or if could not but analysis proceeded on the basis of economic efficiency, the cost-benefit methodology would still suffer problems with the theory of "second-best," the Scitovsky reversal paradox, and the necessity for compensation to actually take place if the original distribution was not optimal in order for the required conditions to hold.

3.2.6 Summary of **the Implications of Objectives on Analysis**

This section has identified that analysis rests on the specification of objectives and that different objectives produce different analysis. Choosing objectives involves a value judgment to be made by society. However, Arrow has demonstrated that there may be no way to resolve the objectives of individuals into a unique social welfare function. If this is the case, then the adoption of any one or several objectives for an analysis is at best a compromise and at worst, irrelevant Because of the social welfare function dilemma, no analysis can claim to be the only possible version. Instead, different and competing analyses have some claim to validity. Even more troublesome is the theory supporting these various objectives which cannot guarantee that the objective will actually be achieved if the results. of analysis are followed.

3.3 ALTERNATIVES AND EVALUATION

Because alternatives are designed as potential solutions to a problem, the way a problem is defined will affect the formulation of alternatives and the specified constraints will limit the number of acceptable ones (Downs and Larkey, 1986, p. 131). For example, alternatives designed at a project level might refer to certain design features of a hydroelectric dam at one project site. At the program level, a variety of hydroelectric projects at different sites could be appropriate alternatives And at the policy level, all possible energy programs would constitute the range of alternatives, including hydroelectric and thermal energy, conservation, and non-conventional alternatives such as geothermal, tidal and solar power.

In designing alternatives, an analyst relies on two sources of information: first, the decision-maker or government agency might provide a list of alternatives; and secondly, the analyst himself may have to seek out alternatives through independent research or in consultation with experts and/or the public. Essentially, the selection of alternatives is a creative process, but two broad types of alternatives do exist: those that differ in nature and those that differ in scale (McKean, 1958; Quade, 1975).

Searching for good alternatives is critical to solving the problem at hand because "it is not possible to choose a better alternative than the best in the set that is considered" (Downs and Larkey, 1986, p. 132). But while it is better to have many alternatives rather than few, time and cost constraints usually prohibit analyzing and evaluating all of them. Some sort of criteria for selecting alternatives must therefore be developed Downs and Larkey (1986, p. 119) fear that the criteria for selecting alternatives is "a highly arbitrary one." Agency bias may exhibit itself not only in the formulation of a problem but in the specification of alternatives. Again, the importance of this to the evaluation phase is that there may be unidentified alternatives which better meet the objectives of the analysis. The result is that,

> While benefit-cost analysis has been advertised, in theory and in getting it accepted as a requirement for water resources projects, as an analytic tool for allocating scarce resources among competing projects, there is little competition in practice. There has rarely been simultaneous consideration of different public projects to accomplish the same objective or different projects to accomplish different objectives" (Downs and Larkey, 1986, p. 119).

In summary, the alternatives chosen for analysis will depend upon the level of analysis (project, program or policy), the perceived constraints upon these alternatives, as well as the sources and interpretation of information about alternatives.

3.4 IDENTIFYING CONSEQUENCES

The identification of project consequences usually means the prediction of future changes to social, economic and environmental parameters that are affected by the implementation of a project or policy. In impact assessment, this usually involves: (i) scoping, or identifying the specific socio-economic and environmental parameters to be measured, and defining the study area and study methodology; and (ii) developing and implementing models for predicting the values of these parameters (see, e.g. Whitney and MacLaren, 1985). These affect the design and outcome of analysis as they require not only considerable knowledge and information, but rely on judgment as well.

3.4.1 scoping

There are three tasks involved in scoping: (i) bounding the problem; (ii) ecological scoping; and (iii) socio-economic scoping (Whitney and MacLaren, 1985). Bounding the problem involves the determination of spatial, temporal and technical boundaries. ***Spatial boundaries*** determine the physical area over which impacts will be measured. These may be determined or influenced by project boundaries, administrative or juridictional boundaries, or ecosystem boundaries. Different types of impacts may well require different boundaries or bring to light conflicting boundaries. For example, the impacts of a dam on fish and wildlife habitat ecosystems would likely extend outside of the immediate project area and might also transcend jurisdictional boundaries by extending across provincial or national borders. In contrast, changes in the availability of agricultural land would most likely be restricted to the vicinity of the reservoir area. Economic impacts might have regional, provincial, national or even international impacts.

Temporal boundaries determine the length of time over which impacts will be measured or predicted These may be influenced by the expected life of the project or by the periodicity of impacts (the time intervals in which they occur). Some impacts may be predominantly short- term with minimal long-term consequences, while others might only become evident after a period of several years. ***Technical boundaries*** define the types of

data to be used in the analysis, the sources of data, the hypotheses or relationships to be tested or measured, sampling frames for measurement and prediction, as well as technical hardware and personnel requirements. Judgment as to the appropriate boundaries to use must be made. Quade (1975, p. 49) remarks that "The determination of the boundaries. . . is largely a matter of judgment supported by very rough analysis."

The second scoping task is **ecological scoping. The** purpose of ecological scoping is to identify the valued ecosystem components (or categories of impacts) likely to be affected by the project in question in order to focus the analysis on the key impacts; the purpose of impact assessment in general is not to duplicate reality but rather to simplify it in a meaningful way. The ecosystem components selected for measurement may be chosen based on scientific values or public values (Whitney and **MacLaren,** 1985) but are also partly derived from the goals and objectives defined for the problem at hand

Socio-economic scoping also takes place in impact assessment Its purpose is to identify the economic variables that will be affected (such as employment levels, construction and operating costs and revenues), social variables affected (such as community disruption, infrastructure changes, lifestyle changes), and community groups likely to be affected (in order to be able to identify and/or evaluate distributional effects, if desired).

The outcome of both ecological and **socio-economic** scoping is a specification of (i) the list of variables to be measured and (ii) the units of measurement, either quantitative or qualitative, for each of these variables.

3.4.2 **Prediction**

The prediction phase of impact assessment involves three component tasks: (i) measurement of baseline conditions; (ii) prediction of future impacts; and (ii) assesment of impact significance.

The existing or baseline conditions of the variables selected in the scoping phase are measured according to the selected spatial and temporal boundaries and established sampling frames. These baseline measurements then become the basis for predicting future changes to these same variables for each of the various project alternatives. Two types of prediction are necessary for project evaluation: predictions of the variables as they would appear with each project alternative and as they would appear ***without** any* project at all. Prediction can be accomplished through a number of methods, such as: laboratory and field experiments, inferential statistics and ecological simulation modelling for the prediction of ecological variables; or econometric and demographic simulation modelling, inferential statistics or surveys for the prediction of social and economic variables (Whitney and MacLaren, 1985).

Significance assessment follows impact prediction and its purpose is to determine which impacts (or changes to variables) are major and which ones are less important and can therefore be ignored for evaluation or project comparison purposes A variety of factors might affect a determination of significance, such as: the magnitude of future impacts compared to baseline conditions, quality standards, policy goals, or compared to future "without project" measurements; effects on stability and resilience; contribution to area- wide cumulative impacts; impact duration; or risk or uncertainty of impacts (see Whitney and MacLaren, 1985).

Downs and Larkey (1986, p. 124) note that "Prediction is *the* critical problem for benefit- cost analysis," and one could add for impact assessment in general, as well. The modelling requirements are indeed enormous to identify the economic, social and environmental impacts of projects. Consider the task of identifying just the environmental impacts resulting from the construction of a hydro-electric dam. These impacts occur either upstream or downstream for a dam site or in the reservoir area itself. The nature of these impacts may be physical, chemical and/or biological (Langford, 1983). Physical aspects include changes in sedimentation patterns, hydrological regimes of surface and ground waters, microclimate change, and induced or increased susceptibility to seismic activity. Chemical aspects include both geochemical and biogeochemical changes in water quality, nutrient levels and trace element levels. Biological aspects include changes in aquatic and terrestrial ecosystems (adapted from El-Hinnawi, 1981, p. 261).

A possible array of impacts resulting from the construction of a hydro-electric dam could include upstream effects such as an increased water table with either increased groundwater availability or waterlogged soils. There may be river channel build-up or aggradation which results in a silty water supply for upstream users or increased upstream flooding. In the reservoir area itself, there may be loss of productive lands which support critical wildlife habitat. The shoreline of the reservoir may lose vegetation and become a barren shore or may suffer bank erosion of up to 12 metres per year if permafrost underlies the flooded area (Geen, 1974; Baxter and Glaude, 1980). Stabilization of downstream flows and the entrapment of nutrients in the reservoir may result in a loss of fish habitat and lowered estuary productivity.

These examples are only a few of the potential effects that may arise from hydro-electric developments (generally, see Baxter and Glaude, 1980). Table 3.1 provides a more detailed, yet still incomplete, list of the possible effects on upstream, downstream and reservoir areas of the dam construction phase, pre-clearing of the reservoir, and subsequent filling of the reservoir. Table 3.1 also describes potential impacts that result after the dam is complete and in operation, such as the impacts of induced erosion, possible water quality changes, the effects of altered flow regimes, biological (habitat) effects in the river system, and the possible results of induced seismicity in the reservoir area,

Potential socio-economic impacts are similarly numerous They may be the result of the economic activity generated by the project or be caused by environmental changes.

These impacts may be classified in four categories: land use effects, recreation-specific effects, aesthetic effects and sociological effects. Land use effects include changes such as the loss of agricultural and grazing lands, loss of lands which support commercial fishing, hunting, guiding, trapping and mining activity, and loss of park or wilderness areas. Recreation-specific effects include changes in the availability of areas for boating, swimming, camping and pi&nicking. Aesthetic impacts may involve changes in scenic vistas, loss of unique areas, and the loss of historical and archaeological sites. Sociological effects include changes in human health and safety, employment, lifestyles, and population patterns (adapted from Ableson, 1979, pp. 78-79). A more complete list of possible impacts is given in Table 3.2.

The preceding discussion has focussed on environmental, social and economic consequences of projects but there are other types of consequences which arise but which might be ignored. Fischhoff et al. (1981, p. 13) identify psychological and political/ethical consequences. Psychological consequences include worry and anxiety, alienation and confidence in the future. Political/ethical consequences may affect the centralization of societal structure, personal freedom, international relations and societal resilience.

Obviously, how predictions are made, and by whom, will have an important bearing on the accuracy of predictions. Because cost-benefit analysis emphasizes the evaluation component of project analysis, it may be that economists and operations researchers are also primarily involved in forecasting. Because of the breadth of the impacts involved in large projects such as dams, these experts may not be the most appropriate; an inter-disciplinary team is probably required.

> For a dam project you may want an electrical engineer to forecast the hydroelectric power that will be produced; a hydrologist to project impacts on water supply; an agronomist to forecast the impact of increased water supply on crop yields; a commodities trader or an agricultural expert to forecast the value of changes in crop yields; and a recreation expert familiar with the area to forecast in consultation with an ichthyologist and a psychiatrist, the recreational usage of the reservoir; and so on (Downs and Larkey,

TABLE 3.1

POTENTIAL EFFECTS OF HYDROELECTRIC DEVELOPMENTS

<table>
<tr><th>EFFECTS</th><th>UPSTREAM</th><th>RESERVOIR AREA</th><th>DOWNSTREAM</th></tr>
<tr><td>Construction Phase</td><td colspan="3">°temporary diversfons (in-stream or tunnels)
°erosion, sedimentation, waste disposal</td></tr>
<tr><td>Pre-Clearing</td><td colspan="3">leave trees
°slope stability in reservoir
°good fish habitat
°dangerous recreational area
°loss of timber value

log trees
°decreased stability
Oincreased erosion
Oincreased recreational value
°poor fish habitat</td></tr>
<tr><td>Flooding</td><td>groundwater effects
Oincreased water table
Oincreased water availability
'waterlogged soil
'contamination of groundwater</td><td>°loss of agricultural land
°loss of timber land
°loss of wildlife habitat
'shoreline ecotone disrupted
°floating sphagnum bogs</td><td></td></tr>
<tr><td>Erosion</td><td>°upstream aggradation
°increased flooding
Oincreased sediment loads</td><td>*permafrost undergoes rapid erosion</td><td>'increased stream bed and bank erosion
'increased meander</td></tr>
</table>

TABLE 3.1 (cont')

EFFECTS	UPSTREAM	RESERVOIR AREA	DOWNSTREAM
Water Quality	°increased sediment load upstream	'suspended materials may settle out °nutrients in sediment trapped in reservoir °release of toxic substances from soil °oxygen-deficient stagnant pools develop °release of P.C.B.'s from power plant °chemicals in agricultural runoff trapped in reservoir	'release of oxygen-deficient water harms fish 'action of spillways/turbines increases nitrogen concentration °downstream waste discharges less dilute 'changes thermal regime of flows
Flow Regime	°increased flooding upstream	'reservoir shoreline vegetation not stabilized by periodic flooding	'reduced flows in spring °more even flows throughout the year °delayed spring break-up 'earlier freeze-up 'increased saltwater wedge °river delta drys up °loss of habitat
Induced Seismicity & Dam Failure		'complete dam failure 'flood waves	'downstream physical damage 'dispersal of chemicals in reservoir waters °e.g., Teton Dam, Idaho °e.g., Vaiont Slide, Italy

TABLE 3.1 (cont')

EFFECTS	UPSTREAM	RESERVOIR AREA	DOWNSTREAM
Biological Effects	'loss of anadromous fishery habitat	'temporary increased lake productivity °increased fish populations °change in fish species 'change in fish parasites	'loss of habitat as side channels dry up 'change in thermal regime detrimental to spawning and rearing fish 'changes in estuary productivity from decreased nutrient loads 'increased nitrogen leads to gas bubble disease

Sources: Ackermann et al., 1973; Baxter and Glaude, 1980; El-Hinnawi, 1981; Geen, 1974; Langford, 1983; Stefan, 1981.

TABLE 3.2

A CHECK-LIST FOR IDENTIFYING
SOCIO-ECONOMIC IMPACTS

Land Use:
- Grazing
- Agriculture
- Fishing
- Trapping/Guiding
- Residential Development
- Commercial Development
- Industrial Development
- Mining
- Resort Area
- Special Purposes
- National Park
- Wilderness
- Port Development
- Defence Establishment
- Active Recreation
- Passive Recreation

Aesthetic:
- Scenic Views
- Natural Bushland
- Open Space
- Landscape Design
- Unique physical features
- Parks & Reserves
- Playing Fields
- Monuments/Historical Sites
- Archaeological Sites
- Visual Impact
- Foreshort Reserves

Cultural:
- Acquisition Effects
- Accessibility Effects
- Noise Effects
- Population Density
- Population Distribution
- Employment Effects
- Cultural patterns
- Human Safety
- Human Health
- Rehousing Effects
- Resident Response
- General Public Response
- Special Area Group Response

Recreation Specific:
- Hunting
- Fishing
- Boating
- Swimming
- Sporting
- Camping
- Hiking
- Picknicking
- General Aviation

Source: Adapted from Albelson, 1979, pp. 78-80.

1986, p. 135).

Not only are the modelling requirements for the prediction of these impacts enormous, but some impacts may be extremely difficult to predict. Causal relationships among system components (whether economic, environmental or social systems) may not be well understood either because the systems are complex and difficult to determine or impossible to determine. As a result, impact predictions may have large margins of uncertainty and some impacts may not have been identified at all. As Quade (1975, p. 166) notes, it was impossible at the beginning of the twentieth century of predict the impact that the motor car would have on lifestyles and economic activity. Similarly, a century ago it would have been difficult to predict the importance of plant and animal derivates in today's pharmaceutical industry (Kellert, 1984, p. 356).

Because of this uncertainty, many predictions might be no more than the educated guesses of experts. Even more sophisticated models are not immune to subjectivity.

> The point is that every so-called quantitative analysis, no matter how innocuous it appears, eventually passes into an area where pure analysis fails and subjective judgment enters. This is important; in applying this judgment the real decisions may be being made. In fact, judgment and intuition do not merely enter quantitative analyses when assumptions are made and when conclusions are drawn; they permeate every aspect of analysis in limiting its extent, in deciding what hypotheses and approaches are likely to be more fruitful, in determining what the "facts" are and what numerical values to use, and in finding the logical sequence of steps from assumption to conclusions (Quade, 1975, p. 164).

Perhaps even more serious than the existence of uncertainty and analyst judgment is the failure to explicitly *recognize* this uncertainty and judgment in the analysis: "not in the use of judgment but in the failure to emphasize the difference in results and recommendations based on judgment alone" (Quade, 1975, p. 165). And if the uncertainty of predictions is not clearly stated, the ***evaluation*** of impacts may be made meaningless. As Downs and Larkey (1986, p. 124) note,

> It is not unusual to find an economist exercising great genius (and spending a lot of time and money) in pricing "recreation user days" or "pain and suffering" when the forecast quantities are only

accurate within 200 percent.

4.0 WHERE ANALYSES DIFFER II

This chapter looks more closely at the cost-benefit evaluation literature to determine how analyses might differ through the application of different evaluation techniques.

4.1 METHODOLOGICAL ISSUES IN COST-BENEFIT ANALYSIS

The process of evaluation is used in two ways: first, to determine if the benefits of one alternative outweigh its costs; and second, to compare several alternatives against each other in order to determine which one alternative best meets the objectives of the analysis. The chosen alternative is selected based on its ratio of benefits to costs; that alternative with the highest benefit/cost ratio contributes most to the achievement of objectives (see Pearce, 1983 for a discussion of the limitations of the benefit/cost ratio). In order for these evaluation tasks to be accomplished,

1. all impacts must be expressed in the same units -- changes in non-market resources must somehow be expressed in dollars;
2. impacts at different points in time must somehow be made comparable -- a decision must be made whether or not to discount future costs and benefits and at what rate;
3. when impacts are uncertain or risky, this must be reflected in the evaluation.

It is in these areas that the cost- benefit literature has much to offer. This section will explore some of the methodological issues at the heart of evaluation.

4.1.1 Non-Market Resources

Non- market resources, also called environmental resources or unmarketed goods, are resources "capable of producing amenity services that are generally consumed "on site," with little or no transformation by ordinary productive processes" (Fisher and Krutilla, 1975a, p. 360). Hufschmidt and Hyman (1982) have grouped these non-market resources into three categories:

1. outdoor recreational services;
2. outstanding scenic, historic, cultural and scientific resources of a collective goods nature; and

> 3. services associated with the capacity of an environment to function naturally and assimilate the residuals of human activities (p. 37).

Changes in the value of these resources are not reflected in any market prices as there are no markets for these goods. In this sense, changes in non-market resources are referred to as external effects External effects arise when two conditions hold: (i) when economic activity in the form of production or consumption affects the production or utility levels of other producers or consumers, and (ii) when that effect is unpriced or uncompensated (Dasgupta and Pearce, 1972).

The existence of resources for which there are no economic markets is a problem in cost- benefit analysis or impact assessment because many project impacts affect such resources. Without markets, an analyst has no direct measure for estimating how people value these resources. He is faced with such questions as: how much is a scenic view worth? How can that worth be expressed? There is no generally accepted method that guarantees correct results. Valuing non-market resources is important in project evaluation in order to be able to compare losses and gains of different types and determine if a project has an overall excess of losses or of gains. It is also important as it facilitates the comparison of different project alternatives. Evaluation, therefore, tries to express impacts of different types (such as the loss of 100 acres of wildlife habitat and an increase in national income) in the same units.

The units in which an analyst usually attempts to express all impacts are dollars, but the units could just as easily be conch shells. *It is important to understand why dollars are used.* Pearce (1983, p. 5) deals with this issue nicely and his comments are reproduced at length here.

> It has nothing to do with being obsessed with money, and everything to do with the *fact* that markets are the only contexts in which individuals express millions of preferences daily. The political system does not begin to compare. We would have to have endless referendums and elections to get remotely near the

> complexity of the market-place, whether it be the local fish market, the Stock Exchange or something as complex as the foreign exchange market. ..
>
> Within these markets countless individuals express their preferences *for* or against goods and services. They vote for them by buying them and against them by not buying them. The means that they use to express their votes is, of course, money. Those votes could be expressed in terms of any measuring-rod. It so happens that money has evolved as a convenient measuring-rod. Had it been cowrie shells or camel bells they would still have been "money", which is simply a word for the medium of exchange. In this respect there can be no objection to a technique which seeks to elicit preferences expressed in terms of money.

This section explores various methods by which non-market resources might be valued or expressed in dollars.

In cost-benefit analysis, a variety of methods for valuing changes in non-market resources have been developed under two general approaches: *economic surrogates* and *hypothetical* valuation. Economic surrogate methods include the travel cost approach (or the Clawson method), property value studies, and related expenditures on complements or substitutes. Hypothetical valuation techniques involve the use of surveys of willingness-to-pay (WTP) or willingness-to-sell (WTS), contingency games, and tradeoff analysis (for a general description of these techniques, see Hufschmidt and Hyman, 1982). The most widely used methods are the economic surrogate methods as well as WTP and WTS surveys. The critical questions about these methods are whether or not they reflect all the changes in welfare or value associated with non-market resources, and whether or not all the changes in value can be measured in dollars.

Practical Problems

Typically, economic surrogate and hypothetical valuation approaches are designed to measure what people would be willing to pay to use a resource. For example, they might assess what one would pay to use a park facility, to have a scenic view, or to reduce pollution in a lake. The measures derived would be approximations of the consumer surplus benefit resulting from the use of a natural environment (Greenley et al., 1981).

Economic surrogate techniques such as the Clawson and related expenditures methods attempt to indirectly assess the value of non-market resources by estimating how much money a person spends to use a non-market resource including the cost of travel and cost incurred for any associated market goods. For example, to estimate the value of a camping ground one might calculate the average expenses incurred for travelling to the site plus assign some portion of the value of goods required on a camping trip (such as tents, fishing rods, etc.). Alternatively, an analyst might look at the difference in property values between an area surrounding a recreational or scenic site and comparable properties not located near to such a site. The higher property values in a scenic area would supposedly reflect the premium people were willing to pay to have access to such a resource.

There are many practical problems involved in applying economic surrogate methods. In the property value approach, it *may* be difficult to find areas with identical characteristics. Differences in property values might easily reflect characteristics other than proximity to a scenic site, such as different community facilities, lower crime rates, less traffic, etc. The related expenditures approach has been used to value recreation benefits and pollution costs, but is weak in the former case because substitutes and complements may also be unpriced, and questionable in the latter as the procedure focuses on equating costs of abatement with demand or worth, an equality which may not hold in an imperfect market of unpriced collective goods (Hufschmidt and Hyman, 1982, pp. 40-l).

Maler (1977) has criticized the property value approach to valuation of environmental quality because it only measures the willingness-to-pay of those who *use* the resource. It thus embodies an implicit assumption that

> an individual is only concerned about environmental quality if he is consuming a positive amount of the private good. Applied to sport fishing the assumption would imply that an individual is concerned about water quality in a lake if he is using the lake for sport fishing. ***If he is not using the lake, then he would not be willing to pay anything for quality improvements in the lake*** (p.

360) [emphasis added].

McAllister (1980, p. 129) criticizes the Clawson method for also failing to reflect the preferences of non-users, while Meyer (1974) expresses concern that this method underestimates use value when a high concentration of users live close to a recreation site. There have been recent attempts in the literature to develop methods to reflect non-consumptive uses of natural resources such as wildlife (see, e.g., Hay and McConnell, 1979).

A common alternative to economic surrogate techniques is the use of hypothetical willingness- to- pay surveys. Through the use of surveys, an analyst directly asks an individual what he or she would be willing to pay to obtain some desired non-market resource such as a camp- ground or a pollution-free lake. While seemingly more simple and direct than the economic surrogate approach, the use of surveys suffers from the difficulty of encouraging people to reveal their true preferences. Fischer (1975) has summarized this problem of strategic bias as follows:

> . . . if people believe their responses to willingness to pay questions will affect their actual taxes or prices they will have a monetary incentive to understate their true preferences or satisfaction levels. On the other hand, if people believe their responses to such questions will not affect their taxes or prices they will have an incentive to overstate their true value estimates. In addition, they have the additional incentive to be a "free rider" on other people's willingness to pay if they believe the government will implement the environmental program regardless of the amount they specify (pp. 31-2).

Problems of bias are not unique to the survey approach but may also be evident in economic surrogate methods. Other types of bias which may exist include information bias, hypothetical bias, and sampling, interviewer and non-respondent bias (see Schulze et al., 1981). In a comparative analysis of six willingness-to-pay studies, Schulze et al. (1981) found no overriding problems with bias and also found that economic surrogate and hypothetical valuation approaches produced similar results

> All evidence obtained to date suggests that the most readily applicable methodologies for evaluating environmental quality -- hedonic studies of property values or wages, travel cost, and survey techniques -- all yield values well within one order of magnitude in accuracy. Such information, in our view, is preferable to complete ignorance.

An additional problem with both economic surrogate and hypothetical valuation techniques arises because these methods generally rely on estimating the preferences of people that actually. use non-market resources. There may be people who do not directly use such resources but who nevertheless derive some benefit from them and who would be willing to pay some amount of money for preservation. Weisbrod (1964) suggested the existence of a value other than use value called option value. Option value is "an amount an individual would be willing to pay to preserve their access to, for example, a park, in the future when they were currently uncertain whether or not they would even actually do so" (Greenley et al., 1981). Two necessary conditions for the existence of option value are (i) uncertain future demand for the resource in question, and (ii) a project which would have some irreversible effect on the resource. An irreversible decision is defined as one that is infinitely costly to reverse (Arrow and Fisher, 1974). Krutilla (1967) classified three components of option value, or preservation benefits:

Option value:	the WTP for the opportunity to choose from among competing alternative uses of a natural environment in the future
Existence value:	the WTP for the knowledge that a natural environment is preserved
Bequest value:	the WTP for the satisfaction derived from endowing future generations from a natural environment (Greenley et al., 1981).

Arrow and Fisher (1974) have shown that option values are distinct from use value, or consumer's surplus. Hence, practical applications of economic surrogate and hypothetical valuation approaches designed to measure consumer's surplus have been criticized for their neglect of option., existence and bequest values. In an experimental study, Greenley et al. (1981) found that option value was non-trivial in relation to use value. Their results showed that the value of benefits from preserving a particular natural environment were equal to $958 million when option, existence and bequest values were included, in contrast to the estimate of $414 million for use value alone. Differences in method in this instance clearly result in differences in analysis.

Theoretical Problems

There are, however, some more troublesome theoretical problems associated with marginal willingness-to-pay measures other than the more practical problems of bias, neglect of non-users and option value. These theoretical problems are associated with the way in which estimates of consumers' surplus (or marginal WTP) are derived. Both the economic surrogate and hypothetical valuation approaches attempt to calculate the amount an individual would be willing to pay to continue their present use of some environmental resource. In the jargon of welfare economics, this is known as the "compensating variation" (CV). There is another measure of consumers' surplus based on the amount of compensation an individual would require to forego their present use of a resource, the "equivalent variation" (EV) (see Gordon and Knetsch, 1979). Many economists have assumed that these two measures of consumers' surplus, CV and EV, would be similar. Furthermore, because it is difficult to calculate CV's and EV's, they have assumed that a simpler method of calculating consumers' surplus can be used to estimate willingness- to- pay. That simple measure, based on changes in prices and quantities irrespective of income effects, is the widely used "Marshallian estimate" (see Pearce, 1983).

There are several problems associated with measuring the consumers' surplus of environmental or non-market resources which affect both the Marshallian estimate and the CV and EV estimates. First, Randall and Stoll (1980) have found that the Marshallian estimate can be validly used to measure consumers' surplus except when analyzing "projects or programs which have the potential to significantly modify unique environments, endangered species, threatened cultures, or the life and health expectancies of human beings" (p. 450). Therefore, the use of a Marshallian estimate for environmental resources may not be valid; instead, CV or EV measures are required

Randall and Stoll (1980) further note that the estimates of CV and EV are likely to diverge for non-market resources. In particular, the CV estimate (or WTP) of a welfare gain will be much smaller than the EV estimate (or WTS) (and vice versa for a welfare loss). The difference between these two measures is usually assumed to be the result of an income effect -- WTP does not reflect the marginal utility of income (Dasgupta and Pearce, 1972, p. 44).

Given two divergent estimates of consumers' surplus, which one should be used for environmental resources, WTP or WTS? (Note that these are more correctly call "marginal WTP" or "marginal WTS".) Krutilla and Fisher (1975, p. 36) state that the correct application of WTP and WTS is to use WTP as a measure of welfare gains and WTS as a measure of welfare losses (see also Meyer, 1979). In a study of fish and wildlife valuation, Meyer (1979, p. 225) claims that

> the welfare criteria ... requiring that for any reallocation of society's resources, gainers must be able to compensate losers, would seem to clearly require that "losses" of fish and wildlife amenities be measured by a willingness-to-sell approach.

In practice, most techniques for measuring consumers' surplus rely on willingness- to-pay. Meyer (1979) suggests that this is the result of earlier beliefs that WTP and WTS did not diverge; but recent evidence to the contrary has not changed the prevalance of the WTP approach. Because the use of WTS involves a very different notion of individual rights than that inherent in WTP, Meyer has also examined the legal positions of individuals with respect to environmental resources, which are also common-property resources. In his estimation, "In Canada, the doctrine of individual rights under a concept of public trust seems not well advanced" (Meyer, 1979, p. 231). Because of this, there is a clearer legal basis for treating government agencies with statutory powers over resources as buyers and sellers (and therefore applying WTP and WTS figures); the legal positions of ***individuals are*** more ambiguous and therefore only WTP measures are ***used.*** Meyer seems to prefer the economic principle over the legal one: the "economic principle would seem to require that the compensatory needs of those citizens experiencing losses be properly considered" (1979, p. 233).

The choice between WTP and WTS measures is not clear-cut because of these differences between economic and legal principles, and it is further complicated by some difficulties surrounding the calculation of either measure. Gordon and Knetsch (1979) attempted to test whether or not the differences between a WTP estimate and a WTS estimate could indeed be explained by an income effect as commonly assumed. Their analysis, while not conclusive, provided "no support for the income effect being the complete explanation of the difference. .. Indeed, the results seem to offer contradictory evidence. The amounts of compensation demanded as well as the willingness-to-pay figures are positively related to household incomes" (p. 5). Randall and Stoll (1980) feel that the information needed to accurately calculate either WTP or WTS "from other measures more readily available to the analyst is less likely to be obtainable" (p. 450). Their conclusion is in sharp contrast to the remarks of Schulze et al. (1980) quoted earlier. Both are reprinted here:

> . . . there may be no good substitute for methods capable of accurately estimating the compensating measure of welfare loss (Randall and Stoll, 1980, p. 450).
>
> . . the most readily applicable methodologies for evaluating environmental quality ... all yield values well within one order of magnitude of accuracy (Schulze et al., 1981, p. 170).

Calculation of WTP or WTS estimates are further complicated by the role that information plays in determining and valuing preferences. Hufschmidt and Hyman (1982, p. 40) question the usefulness of both economic surrogate and hypothetical valuation approaches as they require individuals to possess high levels of rationality and knowledge.

According to Fischer (1975). for an individual to be able to maximize the satisfaction he derives from his income he must have:

> full knowledge about the full range of available goods and services, full knowledge of the relationship between the goods or service and the satisfaction derived, full knowledge of prices of alternative goods and services, full knowledge of money incomes over his planning horizon, and full knowledge that his behaviour will not affect prices (p. 30).

When valuations attempt to estimate the value of environmental quality, for example, this knowledge may not be available because "environmental quality levels are not directly exchanged and are rarely the result of deliberate choices" (Fischer, 1975, p. 32). Therefore, while the amount an individual is willing to pay will depend on his perceptions of the situation, an individual's perceptions may not coincide with what actually occurs. Furthermore, individuals' willingness-to-pay may also reflect perceptions about the effectiveness of their actions. In Fischer's words, "People's perceptions of their role *vis-a-vis* society is as important as their degree of perception of environmental damages" (1975, p. 35).

Ethical Problems

Turing now from these practical and theoretical problems associated with measuring consumers' surplus to some ethical problems associated with evaluation, we see that yet more controversy exists. Roth Hill (1973) and Pearce (1976) are confident that ultimately all effects can be priced -- in essence, this means that people value only what they can buy. A body of techniques to value many different types of environmental resources is rapidly growing (see, for example, recent issues of the *Land* Economics journal). Rebuttals to this assumption have come from many writers, including Fischer (1975), Tribe (1976), Kelman (1982) and Swartzman (1982) in their criticism of the reductionist nature of quantitative techniques. Kelman suggests that assigning a price to a non-market resource may actually ***decrease*** its value for two reasons: (i) due to the loss of positively-valued feelings associated with non-market exchanges (which Swartzman summarizes as the problem of assigning an instrumental value to an intrinsic value); and (ii) because some things may be "not for sale," a label which Kelman says is used as a value-affirming or value-protecting device (Kelman, 1982, p. 147). This notion of something being "not for sale" and having intrinsic value emphasizes the non-utilitarian principles which are by their very nature left out of any quantitative analysis. Tribe (1976) warns that the emphasis of cost-benefit analysis on quantification has moved environmentalism away from being an ethical tenet toward being merely a utilitarian index of costs and benefits, an emphasis which he feels may erode the original sense of obligation expressed in a non-utilitarian principle (see also Dorfman, 1976, p. 167).

The alleged reductionist nature of quantification also tends to foreshorten value discontinuities (Tribe, 1976). A value discontinuity may arise when tradeoffs must be made between utilitarian and non-utilitarian aspects of a decision (Kelman, 1982). For example, assume that a decisionmaker made a decision in the past by choosing a project that involved a risk of ten human deaths. The decisionmaker might have been concerned about a variety of objectives, such as economic efficiency, political acceptability, environmental quality, ethicality, as well as risk to human life. Because some of these concerns may be non-utilitarian, the decisionmaker would engage in ***deliberative judgments*** about these "additional elements ... which cannot be reduced to whether benefits outweigh costs" (Kelman, 1982, p. 142). That is to say, his decision would involve tradeoffs between the economic efficiency calculations in an SCBA and ***several*** non-utilitarian objectives. If we now examine the decision that was made and discover that an alternative project was rejected which had additional net benefits of $100 million but also involved the risk of an additional twenty deaths, we might be tempted to say that the value of one human life is equal to $5 million. We could then use this $5 million figure in future decisions. But Kelman (1982) argues that this calculation, or equivalency, foreshortens the value discontinuities because it does not identify other non-utilitarian tradeoffs that might have been made -- such as human life versus environmental quality versus political popularity or votes (see Section 4.2 for further discussion of ethical frameworks). The equivalency was not used by the original decisionmaker as an input to the decision process; it represents only an end-product which does not fully reflect the process of deliberative judgment.

4.1.2 The **Discount Rate**

Once costs and benefits have been measured in common units such as dollars, cost-benefit analysis attempts to make different cost and benefit streams comparable by discounting future costs and benefits. Roth the basic idea of discounting and the selection of a discount rate are controversial issues. As Pearce (1983) notes, the reasons for discounting future cost and benefit streams arise from the value judgment implicit in cost-benefit analysis that consumer preferences matter. Consumer preferences for discounting future impacts are revealed through the existence of a positive rate of interest in the economy or may be assumed by the notion that people generally prefer current rather than future benefits (Pearce, 1983, p. 38).

In economic theory, there are **two** approaches for calculating a discount rate which reflect the two rationales given above for assigning a positive discount rate. The social opportunity cost of capital (SOCC), or the market rate of discount, equals the marginal return on capital in the economy, net of inflation and including risk Alternatively, the social rate of time preference (SRTP) represents the rate at which society is **willing** to trade present for future consumption (generally, see Baumol, 1968; Pearce, 1983; Treasury Board Canada, 1976).

It has been postulated that the SOCC and the SRTP may not always be identical due to the existence of an ***isolation paradox*** **(Sen, 1961),** in which "individuals would voluntarily enter into a social contract committing them to increase their total savings, for the benefit of future generations, above the level they chose privately" (Warr and Wright, 1981, p. 129). Or in other words, there may be a divergence between individual and social interests, suggesting a SRTP lower than the SOCC. Baumol (1968) suggests that the SRTP should not be higher than the interest rate on riskless government bonds, but could be lower if it was thought that society's perceptions with regard to future generations were myopic. Such myopic perceptions might indicate that resources were being consumed too rapidly (i.e., at a non-optimal rate).

The possible existence of two different interest rates to use for discounting future costs and benefits can be handled in several ways. The first is to estimate both the SOCC and the SRTP and perform the discounting calculations at a variety of rates, such as 5, 10 and 15 percent (Treasury Board Canada, 1976, p. 26). An alternative use of the SOCC and SRTP would be to apply them differentially to project costs and benefits (Pearce, 1983). Costs would then be discounted by the SOCC when financed by borrowing (foregone private investment) and discounted by the SRTP when financed by taxes (foregone consumption). Similarly, benefits accruing as cash flows would be discounted by the SOCC while all other benefits would be discounted by the SRTP (Pearce, 1983, p. 49).

However, the use of a discount rate which is lower than the market rate is not accepted by all economists. Warr and Wright (1981) submit that accepting the existence of the isolation paradox is a matter of individual judgment, and that even if such a paradox is deemed to exist, the appropriate discount rate to use is the market rate of interest Discounting at a rate lower than the market rate does not create a welfare gain Fisher and Krutilla (1975a, p. 370; see also Krutilla and Fisher, 1975, p. 64) claim that if a lower discount rate is applied to any or all projects in the public sector, the result is inefficiency; if applied to all projects 'in the public and private sector, it may actually increase the rate at which exhaustible or non-renewable resources are depleted (see also Scott, 1954, pp. 120-l; for a statement to the opposite effect see Pearce, 1976, p. 151). Fisher and Krutilla find that shadow pricing to reflect the scarcity of natural resources is a more direct way to deal with any myopic views of the current society.

Because of the uncertainty surrounding the selection of an appropriate discount rate, many analyses adopt the approach of discounting at a variety of discount rates around the market rate. In the Planning Balance Sheet formulation of cost-benefit analysis, capital and operating costs are discounted at a market rate; but because Lichfield's use of PBS has involved little quantification of benefits in dollars, he has offered little guidance as to how he perceives PBS should approach the discounting dilemma. Hill (1973, p. 29)) suggests that discounting in the GAM framework should not be done at the market rate but rather at some politically-determined rate, presumably the SRTP, corresponding to social objectives.

The advantage of using a market-derived discount rate is that it is more readily ascertainable than the SRTP. Derivation of the SRTP may rely on government or social judgment: Hufschmidt and Hyman (1982) note that government's time horizons may also be myopic, and partly for this reason Warr and Wright (1981) warn that public policy seldom resembles "the form of all-embracing social contract" required to resolve the isolation paradox and derive a SRTP. The disadvantage of using the market-based SOCC is that it changes over time in response to changes in the amount and distribution of real income, tastes and technological change. Whether the SOCC or SRTP is used, the use of a constant discount rate applied to distant future cost and benefit streams ignores the possibility that market rates or social time preference rates may change in the future.

The practical result of applying any *positive* discount rate against future costs and benefits is to give less weight to future impacts in a cost-benefit calculation. Some critics dislike the implicit ethical assumption of discounting the preferences of future generations (e.g., McAllister, 1980; Pearce, 1983), while others say that using a zero or low discount rate discriminates against the present society by redistributing resources to a probably wealthier future society (Baumol, 1968, p. 801). Several adjustments to cost-benefit analysis have been suggested to accommodate concern for future generations. Pearce (1983) suggests the use of an inter-generational compensation fund based on the premise of applying the Hicks- Kaldor criterion across generations as well as within current society. McAllister (1980, p. 112) would like to limit the use of discounting to "first-generation" costs and benefits, using a zero rate of interest for second and subsequent generation impacts.

4.1.3 Risk, **Uncertainty and Irreversibility**

This section examines the effects of risk, uncertainty and irreversibility on project costs and benefits. Risk is defmed as a situation in which the range of possible outcomes is known, as are the probabilities associated with each outcome. Such probabilities would be objective probabilities based on past experience or on models of system behavior. Uncertainty is defined as a situation in which the range of possible outcomes is known, but the probabilities associated with those outcomes is unknown (Pearce, 1983, p. 73). The types of uncertainty or risk with which this section is concerned are predictive uncertainty -- uncertainty surrounding the estimates of project impacts of consequences and evaluative uncertainty (Quade, 1975, p. 217).

There are two methods for dealing with risk in evaluation The first is to calculate the "expected values" of costs and benefits by multiplying the various outcomes by their probabilities and summing them. This approach requires that individuals be risk-neutral; if individuals, or society, are risk-averse, the "certainty equivalent" of the uncertain costs and benefits must be derived by applying an individual or societal risk-utility function to the expected values (Pearce, 1983, p. 80).

Because society's risk-utility function is difficult to observe, it becomes difficult to calculate this certainty equivalent and resolve risk effects under conditions of risk aversion. Arrow and Lind (1970) have argued, however, that when there are many people across which to pool risks and projects are independent, individual risk is reduced and society may be perceived as being risk-neutral. Environmental risks, or externalities, are generally presumed to be an exception to the Arrow-Lind theorem if they are in the form of public goods -- or bads -- such as pollution, in which case risk can be constant across society (Fisher and Krutilla, 1975b; Pearce, 1983; Price, 1984). For example, noise is a public good but its detrimental effects on a region will not be reduced as the population increases; "consumption" of noise by one individual does not reduce the amount left for others to consume. It is in this sense that noise, or the risk of noise (or acid rain, or nuclear radiation) cannot be pooled.

Because prediction of many environmental impacts is characterized more by uncertainty than by risk, methods for dealing with uncertainty may be more appropriate for evaluation techniques. When uncertainty exists, it becomes impossible to reduce the range of outcomes and probabilities to a single figure, such as the expected value or certainty equivalent, because the probabilities of those outcomes are not known. For example, an analyst might know that a WTP measure for a certain resource was at least $16 but not greater than $24, and that the true value could lie anywhere within this range. But in a situation of uncertainty the analyst would not know the probability of any one of these values. There. are several ways in which this uncertainty can be reflected in evaluation. The first method is to develop subjective probability estimates based on the educated guesse of experts. Using these subjective probabilities an analyst could treat uncertainty in the same way as risk Secondly, an analyst could conduct sensitivity analyses by examining the effect of different WTP measures on the cost-benefit calculations. A third method to reflect uncertainty might be to add a risk premium to the discount rate. But Pearce (1983) and Price (1984) note that when the uncertainty is related to costs, the risk premium may create more optimistic results rather than more conservative ones; and the premium may impose an inappropriate time path on risk

All of these methods for reflecting risk and uncertainty in an evaluation accept either WTP or WTS measures as the basis for evaluation. Recent work by Gallagher and

Smith (1985) suggests that the valuation of environmental uncertainties using conventional WTP or WTS measures may be inappropriate because individuals may value ***certain changes*** differently than ***uncertain changes*** in resources when they are also faced with limited opportunities to insure themselves against this uncertainty. If individuals have access to fair markets to allocate risk, then the valuation of an environmental uncertainty will lie somewhere in between the WTP and WTS estimates. However, "In the case of environmental amenities, ***we*** cannot assume fair markets for contingent claims exist" (Gallagher and Smith, 1985, p. 141).

When fair markets do not exist, an individual's valuation need not fall between WTP and WTS estimates. Rather,

> The appropriate measure is the change in an individual's income that would be required to maintain a given level of expected utility as the probability distribution associated with the availability of the amenity services changes. The magnitude of this income change, or what we will refer to as an access value, depends on the opportunities available to the individual for allocating income among claims to the states of nature at risk (Gallagher and Smith, 1985, p. 136).

The implication of this finding for evaluation is to force a reconsideration of the use of WTP or WTS approaches for valuing changes in uncertain environmental resouces.

Risk and uncertainty may relate to economic, technological, social or environmental parameters. A special type of environmental parameter which has interesting implications for evaluation is the concept of **irreversibility. An** irreversible impact has been defmed as one that is infinitely costly to reverse, and whose authenticity of reversal is questionable (Fisher and Krutilla, 1975b; Pearce, 1983). For example, the decision to build a dam might be reversed at great cost, but the ability to replace the usefulness of the environment for certain types of scientific research is doubtful. Fisher and Krutilla (1975b, p. 278) state that such scientific, ethical, religious or aesthetic concerns might create a highly inelastic demand for "original" environments.

Because irreversibility precludes future use, the concepts of option, bequest and existence values could be seen as premiums for risk bearing (Arrow and Fisher, 1974; Fisher and Krutilla, 1975b). Uncertainty about environmental effects can be partially incorporated in an analysis through the use of these various option values, implying that in the face of irreversible decisions, preservation benefits would increase, thus reducing the net benefits of a development project Irreversible decisions would then affect projects by either (i) decreasing the probability that the entire area in question would be developed, or (ii) reducing the amount of the area that would be developed (Arrow and Fisher, 1974). Cicchetti and Freeman (1971) have shown that option value is positive for risk- averse individuals, implying that option value could simulate the effects of irreversibility in evaluation techniques under conditions of risk-aversion.

The problem with the option value approach is that it is designed to reflect the loss of individual benefits in the future that are derived from environmental systems, but is not related directly to the effect of changing environmental parameters on costs and benefits. Reliance on the option value approach alone would be insufficient as it would not foster increased understanding of environmental systems and could seriously misstate the nature of environmental uncertainty.

Fisher and Krutilla (1975b) explore the effects of changing preferences and changing discount rates on projects with irreversible effects, and use these arguments in support of the conservative estimates derived from including option values. If discount rates change in the future, it is likely that an “economic agent” or decisionmaker will want to revise his original “optimal” plan Similarly, if preferences change in the future such that some effects are valued less than they were in the original society that made the decision, the future society might wish the original decision to be altered. The result of both of these situations might be that future decisionmakers would wish they could go back in time and pay some amount to the original decisionmakers to convince them not to undertake a particular project. Fisher and Krutilla (1975b, p. 288) argue that

> the optimal committment of resources to activities that are (irreversibly) destructive of the environment is smaller than committments to activities whose consequences are reversible. This conclusion is strengthened if there is uncertainty as to the magnitude of the consequences, and inconsistency in their evaluation over time.

Viscusi (1985) has also shown that even if the occurrence of an irreversibility is uncertain the optimal investment decision may be changed However, Viscusi points out that there is no simple rule-of-thumb which says that investment decisions must necessarily change when certain or uncertain irreversibility exists. The probability of an irreversibility, the likelihood of changing preferences in the future, and the weight given to future preferences will all affect the impact of irreversibilities on decisions. Moreover, the effect of irreversibility is modified by the potential to learn more about irreversibility through experimentation (Viscusi, 1985, p. 44).

4.2 VALUE JUDGMENTS IN COST-BENEFIT ANALYSIS

The purpose of this section is to evaluate the extent to which social cost-benefit analysis meets two basic requirements of a decisionmaking framework: impartiality and comprehensiveness (Lichfield et al., 1975; Copp and Levy, 1982). Impartiality refers to the extent to which value judgments, or normative propositions, are evident in a decision-making process. Comprehensiveness refers to the ability of a decision process to reflect in its framework a variety of moral principles, and within each principle, its ability to include all relevant factors or effects.

4.2.1 Impartiality

The normative aspects of social cost-benefit analysis can be analyzed by outlining the value judgments required in the cost-benefit methodology. Nash et al. (1975) and Pearce (1976, 1983) have identified two value judgments which must be made: that *preferences* count, and that these preferences must be weighted. The first value judgment requires consideration of whose preferences to count and when to include those preferences. The issue of which *type* of preferences are included (also part of this first value judgment) will be discussed separately in the section on moral frameworks and cost-benefit analysis (Section 4.2.2). The second value judgment requires the analyst or decision-maker to make a statement about how individual preferences will be weighted and aggregated

Value Judgment #1: Preferences Count

Whose Preferences: Cost-benefit analysis addresses the question of whose preferences to include by using the preferences of the individuals in society. This is evidenced by an admitted reliance on general social welfare as the proper focus of public policy decisions (Krutilla, 1961, pp. 226-7). In this conception of social welfare, “only benefits to man matter” (Abelson, 1979, p. 39), and this becomes the benchmark for economic policy analysis tools in general (Tribe, 1976). In cost-benefit analysis, values attached to the environment are included in an analysis only insofar as they have instrumental value:

"values attached to the environment in its own right and without reference to human use . . . are normally ignored in CBA" (Abelson, 1979, p. 38). An objective with instrumental value is desired for its contribution to some supraordinate objective or goal, such as human happiness or welfare, while an objective with independent value is legitimate in its own right, such as an ethical or religious principle.

Cost-benefit analysis therefore does not attempt to determine preferences not associated with persons, such as the preferences of plants and non-human animal life. Determining plant and animal preferences connotes somehow asking these organisms what they would like, which of course sounds reasonably ridiculous. The neglect of instrumental values can be visualized in a much more subtle, and reasonable, way if we think in terms of ecological stability. Any evaluation technique designed with human preferences in mind may neglect the importance of the life-supporting nature of the natural environment and the irreplacability of it.

While individual preferences are included in cost-benefit analysis, it might be possible that the preferences of *all* individuals are not reflected. For example, McAllister (1980) states that children, the mentally ill and the senile may not be considered in a decision. Hurter et al. (1982, p. 91) imply that those not directly affected by a project, who suffer only some psychological disbenefit, should not be included But these exceptions are not widely accepted and may in fact be inconsistent with the value judgment that individual preferences count, Nash et al. (1975) hold that by accepting that individual preferences count, one necessarily accepts the preferences of all individuals. Krutilla (1961) substantiates this with his claim that cost-benefit analysis should focus on the general welfare of all individuals rather than on "personal or specially interested clients" (see also Winch, 1971, p. 13). Tribe (1972) warns that there is nevertheless a risk of excluding those preferences "too widely diffused over space (or too incrementally affected over time) to be strongly championed by any single client of a policy analyst"

Furthermore, the analysis generally includes only the preferences of current generations (Dasgupta and Pearce, 1972; Tribe, 1972). To acknowledge the preferences of future generations, one must have access to knowledge of what future preferences might be, or assume that future generations will have preference structures similar to the present Even if the latter is assumed, the practice of discounting future costs and benefits gives less weight to future preferences. Because it is impossible to objectively determine future preferences, some ***analysts*** have suggested modifying the rules for discounting future costs and benefits to partially acknowledge the possibility of changing preferences in the future.

When to include individual preferences: Individual preferences for goods and services are usually measured by activity in competitive markets. The existence of ***public or collective goods*** in a competitive economy, however, often results in an undersupply of such goods by private markets (Gramlich, 1981, p. 19). Public goods are characterized by (i) non-excludability and (ii) non-rivalry of consumption (Pearce, 1976, p. 20). Non-excludability means that the goods, if made available to one person, are available to all persons. Non-rivalry of consumption means that consumption of a public good by one individual does not make less of that good available for other individuals. An example of a public good is national defence, while an example of a public "bad" would be pollution. Government intervention to increase their production (or limit them in the case of pollution) is undertaken not to override individual preferences but to correct a market failure which prevents individual preferences from being fully reflected in market activity.

Value Judgment #2: Preferences must be weighted

Preferences must be weighted in order to be aggregated in some meaningful way. Several possible methods for weighting preferences have been put forward: the Pareto principle, the Hicks- Kaldor rule, Utility weights, Willingness-to-sell, Market Voting, and the Management Science approach (see Nash et al., 1975). The general approach of these methods is to somehow reflect the intensity of individuals' preferences, unlike voting or referenda which given equal weight to the preferences of all individuals.

The Pareto *principle was* derived from Vilfredo Pareto (1848- 1923) and says that for one project to be better than another, at least one person must be made better off and no one made worse off. This would mean that no project which resulted in a net cost to any one person would be undertaken. Because almost all projects impose some costs on individuals, this rule is a very strict one. In the 1930s, two economists, Hicks and Kaldor, developed a modification of the Pareto principle, called the *Hicks- Kaldor rule,* in which the sum of benefits to beneficiaries of a project must exceed the sum of costs to losers for that project to be acceptable. This is also known as the “compensation test," whereby winners *could* compensate losers but need not actually do so. Welfare economics, and cost-benefit analysis, is based on the Hicks- Kaldor rule.

The *Hicks- Kaldor rule* relies on measuring the strength of preference of all individuals affected by a project by calculating each individual’s willingness-to-pay (WTP) to avoid a cost or guarantee a benefit The WTP method relies on the prices of goods and services in the marketplace as estimates of WTP. Because these prices reflect the existing distribution of income (see Krutilla, 1961), use of the Hicks-Kaldor rule involves making a value judgment “that the distribution of income used to weight the preferences of individuals is in some sense the best one” (Pearce, 1983, p. 6). The WTP method, based on the concept of consumer sovereignty, has been criticized for the simple but significant fact that an individual’s WTP is constrained by his income, creating what some have called a “dollar democracy” (Krutilla, 1961; Foster, 1966) in which the individual’s “vote” in the social welfare function is weighted by his income.

To illustrate, suppose that individual A earns $15,000 per year and individual B earns $100,000 per year, and suppose that both are in favor of preserving a forested area from a mining development Let us also assume that both men feel equally strongly about this (in practice, this would be exceedingly difficult to measure). Suppose that individual B is willing to pay ten percent of his income, or $10,000, to preserve the area from development. It is unlikely that individual A could afford to pay $10,000 from his much smaller income but would perhaps instead be willing to pay ten percent of his own income, or $1,500. Although both individuals might be willing to pay equal proportions of their incomes, it is dollar values rather than proportions which are used to evaluate preferences. Therefore, while individual A might like to pay $10,000 if his income were larger, because his income is smaller, his WTP is constrained by the level of his income.

The use of value judgment # 2, therefore, often causes cost-benefit analysis to reflect consumer preferences based on income levels rather than individual preferences irrespective of income. Some economists argue that this becomes a problem only if the existing distribution of income is not viewed as ideal by society; if it is optimal, they argue, then it is legitimate to have preferences constrained by income, a notion which still remains unpalatable to some critics. Even if the distribution of income is optimal, critics argue that the practical result of reflecting that distribution in cost-benefit analysis will be to continue to make the poor worse off because their preferences have less weight than the preferences of the wealthy (see, e.g. Pearce, 1983, p. 7).

An alternative measure of individual preferences is based upon willingness- to-sell rather than willingness- to- pay. The *willingness- to- sell* (WTS) approach overcomes the income effect of WTP by asking individuals what they would be willing to receive in compensation for giving up a right rather than what they would be willing- to-pay to receive or maintain a right. The application of WTS in cost-benefit analysis seems to be limited to situations in which the cost or benefit received by an individual results from something to which he has a *right* (see Banford et al., 1980, p. 34; McAllister, 1980, p. 98; Dasgupta and Pearce, 1972). If an individual does not have a right to some resource, his valuation of that resource will be constrained by his income in a WTP calculation. If he does have some right, such as a property right, WTS would be used and his compensation might well exceed his WTP.

This highlights an additional normative proposition in cost-benefit analysis that valuations should reflect the existing distribution of property rights (Dasgupta and Pearce, 1972). But property rights present a relatively unambiguous interpretation of rights that inhere with an individual. More controversial are individual rights to clean air or water, usually evaluated with WTP measures as if they were not rights that belonged to individuals. Tribe (1976, p. 66) argues that some rights, such as the right to see or breathe, belong "to the individual because the capacity it embodies is organically and historically a part of the person that he is and not for **any** purely contingent and essentially managerial reason" Ultimately, the decision to use WTS figures necessitates a value judgment about the types of rights which society is willing to grant to an individual.

Utility weights may be used to weight WTP figures if the distribution of income in society is not optimal. These weights provide a more "pure" measure of the intensity of an individual's preference which is not affected by income levels. Equity weights may be combined with utility weights, making a value judgment about a socially desirable distribution of utility. However, as Nash et al. (1975) note, there is "nothing necessarily 'fair' or 'democratic' in such an approach" (p. 128).

What Nash et al. (1975) call the *Market Voting* principle is a weighting scheme designed to measure strength of preference, or WTP, as if every individual had the same income. The Democratic Strength of Preference rule was put forward by Foster (1966), incorporating some of the characteristics of preceding weighting rules. In the Democratic Strength of Preference rule, social costs and benefits (other than financial flows) would be weighted by the ratio of mean population income to the income per head. This approach would measure strength of preference and equalize the income constraint by scaling down the WTP measures of high income individuals while **scaling** up the WTP measures for low income individuals.

Finally, Nash et al. (1975) suggest a ***Management Science*** approach to weighting in which WTP weights would be derived from the weights implicit in past policy decision. Use of this approach is based on an assumption that past policy decisions have been optimal.

In summary, these value judgments emphasize the normative nature of cost-benefit analysis, indicating that it is not a value-free or impartial process. Different analyses will result when different value judgments are used Copp and Levy (1982) and Self (1975) have additionally shown that cost-benefit analysis is not value-free or impartial by looking at the theory of cost-benefit analysis as part of the theories of rational and moral choice. In essence, their argument states that cost-benefit analysis, in its pursuit of objectives (such as economic efficiency), are part of the theory of rational choice and as such a part of value theory (Copp and Levy, 1982, p. 165; Self, 1975, p. 9). In other words, objectives are defined in order to achieve certain values or goals; they cannot be "rational" without some reference to values (Winch, 1971, p. 25). If a social welfare function cannot be defined, then social values are just as ambiguous. The dilemma for analysis is whose values to use? An inability to solve this dilemma means analyses based on different values have some claims to validity.

Copp and Levy also argue that, in cases such as the Prisoner's Dilemma where individual utility maximization does not lead to a collective utility maximum, the concept of rationality as utility-maximiring behavior is questionable (1982, p. 165). Garrett Hardin's (1968) "tragedy of the commons" is a typical example of a Prisoner's Dilemma. In the tragedy of the commons, individuals making rational decisions in their own self-interest bring about a collective disaster because long-term collective costs have been ignored (see also Messick and Brewer, 1983; Schelling, 1978). Hill (1973) who claims that GAM is a more rational method than SCBA or PBS because it avoids predetermined objectives, does not escape the Prisoner's Dilemma. The following section will show that, because cost-benefit analysis relies on utilitarian principles, it is also part of the theory of moral choice, and therefore also part of value theory (Copp and Levy, 1982, p.165).

4.2.2 Moral Comprehensiveness: Ethical Frameworks

Moral comprehensiveness refers to the ability of a decision process to reflect a variety of moral principles and hence its ability to be ethically neutral. Can analysis simultaneously accomodate different ethical frameworks or does analysis vary with the ethical framework adopted? According to Pearce (1983). value judgment #1 -- that preferences count -- involves making a decision concerning the type of preferences that should be included in an analysis or decision process. If all types of preferences are included, then the decision process is said to be ethically neutral.

Cost-benefit analysis is based upon a particular type of moral principle called utilitarianism. Utilitarianism is a form of ***consequentialist mural principles*** which "appraise actions on the basis of the consequences they can be expected to produce" (Copp and Levy, 1982, p. 167). There are two types of consequentialist moral principles: maximizing (or utilitarian) and non-maximizing. ***Maximizing*** **consequentialist** principles, or utilitarian principles, involve undertaking actions in which good consequences outweigh bad ones. This is clearly the principle upon which the Hicks- Kaldor rule used in cost-benefit analysis is based. ***Non-maximizing*** consequentialist principles are based on the same concept but include the notion of a threshold of harm, "such that, if an action's consequences exceed that threshold, then it would be wrong, and no amount of good would tip the balance" (Copp and Levy, 1982, p. 168). In contrast, ***non- consequentialist moral principles*** do not judge actions based on a weighting of their good and bad consequences, but instead deem certain actions right or wrong for their intrinsic nature.

Because cost-benefit analysis is based on utilitarianism, it is not well suited to reflect either (i) non- maximizing consequentialist principles or (ii) non-consequentialist moral principles (Copp and Levy, 1982). At best, moral principles other than utilitarian ones can be included in a cost-benefit analysis only as constraints or qualitative factors acknowledged in a report because the analysis relies on a comparison of good consequences, or benefits, with bad consequences, or costs. It cannot be said that cost-benefit analysis is ethically neutral as it favors the views of those who hold maximizing consequentialist principles (see Copp and Levy, 1982, p. 168). Similarly, it can be said that welfare economics "is a branch of ethics" based on utilitarian principles (Little, 1957, p. 8).

These moral principles which cannot be incorporated in an analysis are more commonly referred to as intangible, fragile or unquantifiable values (Tribe, 1976, p. 63). By way of example, McAllister (1980) questions the ability of a technique to reflect in any quantitative way an ethical view that plants and animals have rights, a religious view that nature is God's work, or an ecological view that man's well-being is intimately linked to the well-being of nature (p. 131). Brooks cautions that not only may such values be incapable of quantification, but it may even prove difficult to identify and articulate them (1976, p. 119; see also Tribe, 1976).

*Difficulty in reflecting a variety of moral principles is a limitation shared by most techniques, and as Tribe (1976, p. 65) points out, difficulties in dealing with intangible values or principles reflects "not any intrinsic weakness of the analytic methodology as applied to non-monetizable values, but rather the universal difficulty of choosing among incommensurables -- a difficulty that can be obscured but never wholly eliminated by any method of decision making." The importance of this limitation is to emphasize that a cost-benefit ratio will be excluding the views of individuals who hold other than maximizing consequentialist principles, unless such views are formulated as constraints. To the extent that such people and principles are evident, any cost-benefit analysis will not be morally comprehensive and may thus risk being misinterpreted

The impact that moral frameworks can have on an evaluation is illustrated in a study by Schulze and Kneese (1981). Because many environmental externalities have long- term and sometimes irreversible consequences, Schulze and Kneese explore the implications of different ethical Frameworks on the acceptability of uncompensated risk They show how the outcome of analysis differs according to the ethical framework chosen. A typical example would be the risk of dam failure which is not only an uncompensated risk but one which is rarely include in cost-benefit calculations (see Baecher et al., 1980). By applying distributional weights based on income, Schulze and Kneese (1981, p. 86) derived the following results: where a ***utilitarian- based*** cost-benefit analysis would accept uncompensated risk regardless of the incomes of individuals, a ***utilitarian ethic adjusted for income*** and an ***egalitarian ethic*** would reject uncompensated risk on those with lower incomes, while an ***elitist ethic*** would reject uncompensated risk imposed on those with higher incomes, and a ***libertarian ethic*** would reject all uncompensated risk. Furthermore, utilitarian-based cost- benefit analysis would not protect individual rights against majority rule, while such rights would be protected in egalitarian elitist, libertarian and income-adjusted utilitarian ethical systems (Schulze and Kneese, 1981, p. 88).

Several authors have suggested that too much blame for the neglect of certain moral principles should not be attached to the utilitarian concept underlying the various evaluation techniques. Tribe (1976) has noted cost-benefit analysis' reliance on maximizing utilitarian principles does not necessarily force a narrow conception of social welfare based only on evaluating impacts on humans. According to Tribe (1976, pp. 70-1), "Such utilitarian philosophers as Bentham [perceived] human obligations as extending to all entities capable of experiencing pleasure and pain" Dorfman (1976, p. 162) has also pointed out that the utilitarian J.S. Mill recognized that "social policy must be informed by higher moral purpose." In the words of Mill, himself,

> We may consider, then, as one criterion of goodness of a government, the degree in which it tends to increase the sum of good qualities [moral and intellectual] in the governed, collectively

> and individually; since, besides that their well-being is the sole object of government, their good qualities supply the moving force which works the machinery (p. 337).

Brooks (1976) suggests that by broadening the definition of utilitarianism, a wider variety of moral principles might be incorporated in an analysis. In effect, this means being able to somehow create surrogate markets for values not normally expressed in a competitive marketplace: "We can go a long way, at least in principle if not in practice, in treating nature like any other economic investment for a future stream of economic benefits" (Brooks, 1976, p. 121)

4.2.3 Summary of Value Judgments and Analysis

This analysis of the value judgments implicit in cost-benefit analysis has shown that welfare economics assumes the proper basis for government decision-making to be the social welfare of all individuals, not the welfare of decision-makers, bureaucrats or special interest groups. As a result, a cost-benefit analysis is based on the preferences of individuals in society, and these preferences must be capable of being expressed in economic markets. Because cost-benefit analysis is based on utilitarian principles, the preferences of individuals who hold non-utilitarian principles might be excluded from the analysis. Similarly, individual preferences might be ignored if a government wishes to correct market failures or act in a paternalistic manner toward certain groups of individuals. A cost-benefit analysis might weight or measure preferences based on income levels and may often assume that the distribution of income in society is optimal. While preferences are constrained by an individual's ability to pay, they could be weighted in some manner to reflect social judgments about the deservingness or social worth of the preferences of certain individuals. And finally, preferences are aggregated on the basis of total costs and benefits to society rather than on the number of individuals suffering costs or benefits -- total benefits must exceed total costs, but the number of people receiving benefits need not exceed the number of people suffering costs.

(The purpose of highlighting these value judgments is not to condemn cost-benefit analysis because of them. As Pearce (1983) notes, value judgments ***must*** *be* ***made*** about which preferences to count and how they will be weighted. But,

> If we remember that value judgements are inescapable in reaching policy decisions and that such value judgements can themselves be argued about, CBA can be an extremely useful tool of decision-making. For by making such judgements explicit and, as far as possible, spelling them out in precise quantitative terms, it makes clear thinking about policy matters possible" (Dasgupta and Pearce, 1972, p. 93).

This arguing about value judgments is often at the heart of competing analyses. ultimate value judgments are difficult to make because different people will want to use different value judgments. Because of this, cost-benefit *analysis* might be better viewed as an exploration into problem-solving rather than as an algorithm for problem-solving

5.0 THE SITE C NEGOTIATIONS: AN IMPACT ASSESSMENT PROCESS

The cast study chosen for analysis centers on the negotiations surrounding the decision to delay construction of a hydroelectric development in northern British Columbia The Site C dam and generating station was first proposed in 1975 by B.C. Hydro, a provincial crown corporation responsible for supplying the energy requirements of the province of British Columbia. The dam was to be located on the Peace River, downstream from two existing hydroelectric developments (the Bennett Dam and the Peace Canyon Dam). Largely due to the potential environmental damage of the Site C dam and doubts about the necessity of additional generating capacity, considerable opposition to the proposed project arose. A series of public hearings were held under the auspices of the B.C. Utilities Commission between 1981 and 1983 in which B.C. Hydro's cost-benefit analysis of the Site C project was examined. Finally, a decision was made by the provincial Cabinet in November 1983 which held that the Site C dam would not be built at that time. The goal of this chapter is to identify the main actors involved in the impact assessment process and to compare and contrast their different perceptions: how they each define the problem at hand, the objectives, alternatives, consequences and evaluation methods. The aim is to determine if, indeed, their perceptions supported different analysis. The information on which this section is based is taken from three major sources: (i) the written submissions of various groups to the B.C. Utilities Commission, (ii) newspaper reports during the period under analysis, and (iii) the final report of the B.C.U.C. (1983).

The negotiations which took place occurred primarily between B.C. Hydro (the project proponent) and various citizen groups opposed to the project These negotiations took place within the impact assessment framework specified by the B.C. Utilities Commission, which reported ultimately to the provincial Cabinet. The opposing citizen groups can be loosely grouped into two categories: (i) provincially-based environmental organizations and (ii) associations of local residents. The most active provincially-based group was the Society Promoting Environmental Conservation (S.P.EC.). The most vocal association of local residents was the Peace Valley Environmental Association (P.V.E.A.). Although there were other project proponents (such as Chambers of Commerce, labour unions and various industry associations) as well as other opponents (including Regional District boards, native indian bands and other private citizens), these groups played much smaller roles in the impact assessment process than S.P.E.C. or P.V.E.A. This analysis will therefore focus on the concerns of the key actors: B.C. Hydro, the B.C. Utilities Commission, P.V.E.A. and S.P.E.C, and various government ministries

The nine year period chosen for analysis (1975- 1983) can be divided into three phases, derived by bounding the major events that occurred. The first phase, *Project Initiation,* extended from 1975 to 1976 and represented the initial announcement by B.C. Hydro and the subsequent reponse by project opponents calling for a comprehensive project review process. The second phase, *Project Analysis,* lasted from 1977 to 1980 and is characterized by the emergence of arguments both for and against construction of the Site C dam and the introduction of impact assessment legislation, the *Utilities Commission Act. The* third phase, *Evaluation and Resolution,* spanned the years 1981 to 1983 during which the Utilities Commission hearings took place, culminating in the provincial Cabinet's decision in November 1983 to delay the project

Project Initiation - 1975-1976

B.C. Hydro initiated the Site C negotiations in 1975 with its announcement that planning for the construction of the Site C dam would begin. In particular, environmental, social and economic impact studies on the Site C project were to be commissioned. Preliminary impact reports released by B.C. Hydro in 1976 indicated that the earliest completion date for the project would be 1984. In response to these announcements, residents of the Peace River valley opposing the project joined together to form the Peace Valley Environmental Association (PVEA). At the same time, existing provincial environmental groups such as the B.C. Wildlife Federation, the Sierra Club and SPEC, voiced their concerns about the adequacy of the process by which hydroelectric developments were evaluated.

At the time that B.C. Hydro proposed to build the Site C dam, no formal process for the overall evaluation of energy policy and supply alternatives existed in B.C. The provincial environmental groups which voiced their concerns in the mid-1970's wanted not only a complete evaluation of Site C including some mechanism for public participation, but an evaluation process which would apply to all energy projects.

Project Analysis - 19774980

The second phase of the Site C negotiations is characterized by the emergence and development of arguments for and against the Site C project Opponents, led by PVEA and SPEC were active in disseminating information about their positions and the project by raising funds, producing pamphlets and remaining vocal in the media. They also challenged B.C. Hydro's decision to build Site C by asking (i) if additional power was needed in the province, and (ii) if so, if Site C was the best energy project to meet those needs. B.C. Hydro's actions during this period consisted mainly of performing a variety of impact studies, including a cost-benefit analysis which justified the need for Site C and showed that its social benefits were greater than its costs. B.C. Hydro's chairman was critical of "self-styled environmentalists" who pursued "selfish interests" and opposed any hydroelectric project with "well-organized propaganda" (Vancouver Sun, 1978). Late in 1979, B.C. Hydro continued to claim that Site C was the "most feasible, lowest cost supply relative to all other alternatives" (Province, 1979). In October 1979, B.C. Hydro formally applied for the necessary licences and permits under the B.C. Water Act.

Several months after B.C. Hydro's application was made, the provincial legislature passed the ***Utilities Commission Act*** (SBC 1980, Chap. 60) which set forward detailed guidelines for the review of energy projects and provided for public participation in the form of hearings, if requested by Cabinet. B.C. Hydro r-e-applied under this new process in November 1980.

Project Evaluation and Decision - 1981-1983

During the third phase of the Site C negotiations formal public review of the Site C project began under the provisions of the *Utilities Commission Act. The* hearings were conducted by the B.C. Utilities Commission and proceeded in five stages: (i) project justification based on energy supply and demand analysis; (ii) Site C project design; (iii) environmental, land use, social and economic impacts of Site C; (iv) financing; and (v) other matters relating to the issuance of specific permits. During the hearings the arguments of opponents and proponents were presented, and additional evidence was provided by numerous provincial government ministries.

The role of the Utilities Commission was to judge the competing evidence and analyses, and present its own recommendation to the provincial Cabinet on whether or not to proceed with Site C. The Utilities Commission found that B.C. Hydro's energy demand forecasting overestimated actual demand and that no new project was needed at that time. Furthermore, it found that B.C. Hydro had not proven that Site C was the best project to undertake as B.C. Hydro had considered too few project alternatives in its cost-benefit analysis. The Commission recommended to Cabinet in May 1983 that Site C not be built until:

> (a) an acceptable forecast demonstrates that construction must begin immediately in order to avoid supply deficiencies and
> (b) a comparison of alternative feasible system plans demonstrates, from a social benefit-cost point of view, that Site C is the best project to meet the anticipated supply deficiency (B.C.U.C., 1983, pp. 1041).

The Utilities Commission also recommended that Cabinet. "direct the B.C. Utilities Commission to hold public hearings, strictly limited to the issues of load growth and alternative system plans, to assist it in making these determinations" (B.C.U.C., 1983, pp.

126- 7).

The provincial Cabinet released the Commission's recommendations to the public in November 1983 and simultaneously announced its own decision. The Energy Minister announced that the Site C project would not be constructed and that further public review would not be necessary (Vancouver Sun, 1983).

5.1 DEFINING THE PROBLEM AND ALTERNATIVES

The problem facing B.C. Hydro in the mid-1970's was the possibility of an eventual shortage of electric power supply. Because the planning and development of energy sources such as hydroelectric or thermal takes from five to ten years, B.C. Hydro required an adequate lead-time to be able to fulfill electricity demand. A key question which B.C. Hydro had to address was therefore when future demand would exceed the existing supply of electrical power. The year in which demand outstripped supply would become the required "in-service" date of any new electrical generating facilities. Once this in-service date was determined, B.C. Hydro -- which conducts ongoing studies on the feasability of various supply possibilities -- had to examine its arsenal of supply alternatives to determine which projects were capable of being constructed by the desired in-service date.

B.C. Hydro's problem was therefore not an immediate one but an anticipatory one; because of the long lead-time needed to construct electrical generating facilities, it needed to predict when such facilities were to be needed at least five or ten years in advance. Predicting future electricity demand was therefore central in defining the problem And the sooner that future demand could be accurately predicted, the more supply alternatives that could be considered After all, if demand will exceed supply in one year's time it will not be possible to meet that demand by starting construction of a hydroelectric project which will take five or more years to complete.

Because B.C. Hydro's problem was anticipatory, prediction was the key element in problem definition. Similarly, the accuracy of prediction was extremely important Starting construction too late might result in supply shortages or necessitate the temporary purchase or generation of more costly sources of electricity. Conversely, overbuilding -- completing projects too early -- might needlessly tie up capital and resources in unused facilities To avoid these potentially costly results, B.C. Hydro faced the challenge of finding the fine line between underbuilding and overbuilding.

Because predicting future events is rarely done with certainty, B.C. Hydro approached its forecasting problem by generating three possible energy demand scenarios: low, medium and high. For each scenario a required in-service date was calculated, and for each in-service date a list of possible project alternatives was derived This approach is represented schematically in Figure 5.1. Throughout the Site C hearings, B.C. Hydro claimed that Site C was the "most practical and economic project to generate the additional electricity required to meet future demand" (Province, 1980).

While B.C. Hydro's main concern was to supply electricity, S.P.E.C.'s concern was to insure that all energy developments, including Site C, were assessed in some sort of comprehensive review process. S.P.EC. and other environmental groups had been advocating the development of energy project review procedures at least since the mid 1970's (Vancouver Sun, 1977; Daily Colonist, 1978; Vancouver Sun, 1980). S.P.EC. also advocated the consideration of conservation and renewable energy alternatives (Vancouver Sun, 1980; Cooper, 1982).

Throughout the Site C hearings, S.P.E.C.'s framing of the problem consisted of asking: (i) is additional power needed in the province; and (ii) if so, is Site C the best energy project to meet those needs S.P.EC. believed that their efforts were best spent addressing the first question as they were confident that additional power was not required within the time frame proposed by B.C. Hydro. It if were shown that additional power was needed, S.P.EC. believed that Site C was not necessarily the best project; they felt that several alternatives had been excluded from B.C. Hydro's analysis (such as demand

FIGURE 5.1

B.C. HYDRO PROJECT JUSTIFICATION

LOW DEMAND SCENARIO	MEDIUMDEMAND SCENARIO	HIGH DEMAND SCENARIO
projected deficit 1988	projected deficit 1986	projected deficit 1984
SUPPLY ALTERNATIVES 1. Site C 2. Hat Creek 3. Murphy Creek 4. East Kootenay	SUPPLY ALTERNATIVES 1. Site C 2. Hat Creek	SUPPLY ALTERNATIVES none identified

Source: B.C. Hydro, 1980a, p. II-11, II-12.

management through pricing, conservation, and geothermal energy).

The problem facing the Peace Valley Environmental Association had little to do with energy supply for the province of B.C. Their goal was to prevent *all* projects planned for the lower Peace River (Province, 1976). The implication this carries is that they would not accept the construction of Site C even if were shown to be the best project from a social benefit/cost point of view.

The B.C. Utilities Commission's definition of the problem was defined in a general policy statement of the Ministry of Energy, Mines and Petroleum Resources (1980) and in the specific terms of reference drafted for the Site C hearings by the Ministers of Environment and Energy, Mines & Petroleum Resources. The policy statement said that energy project reviews will

> examine the broad justification for the project, including energy demand projections, alternative energy sources (including conservation) and general environmental and social factors.
> . [and] examine specific environmental concerns, mitigation measures and other detailed factors ... [undertaken] within the guidelines defined by the provincial Environment and Land Use Act (Ministry of Energy, Mines and Petroleum Resource, 1980, p. 13).

In the terms of reference for the Site C review, these "guidelines" were defined as the guidelines for social benefit-cost analysis published by the Environment and Land Use Committee (E.L.U.C., 1977). The Utilities Commission was therefore required to determine two basic issues: (i) if energy demand justified the construction of a new hydroelectric project, and (ii) ascertain the social costs and benefits of Site C (B.C.U.C., 1983, p. 38).

During the Utilities Commission hearings, several problems with B.C. Hydro's problem definition became apparent The first problem was the inaccuracy of B.C. Hydro's energy demand forecasts. Specifically, their techniques for estimating demand were based on relatively unsophisticated non-econometric models, did not consider statistically significant past behavior, and did not incorporate price effects (B.C.U.C., 1983, p. 4). As a result, the medium demand scenario, which B.C. Hydro believed was the most likely scenario, reflected the maximum possible demand rather than the most likely demand (p. 5). S.P.E.C. commissioned a study (Over-stall, 1982) to confirm a sample of B.C. Hydro's demand projections for a number of large industrial consumers. In a sample of 28 companies, S.P.E.C. was able to confirm only 49% of the future demand claimed by B.C. Hydro for these same companies (Overstall, 1982, p. 2).

The second problem, which stems from the first, was the incomplete analysis performed on the low and high demand scenarios. Actually, no analysis beyond identifying possible alternatives was performed. The cost-benefit analysis which B.C. Hydro conducted was based entirely on the medium demand scenario. Two possible projects, Hat Creek and Site C, were compared based on the required in-service date of the medium demand scenario. When the B.C. Utilities Commission (1983, p. 4) determined that this medium-demand scenario overestimated future demand, B.C. Hydro was left with no analysis to support the construction of any project. Had an analysis been done on the low-demand scenario as well, those results might have been more applicable. This situation highlights the importance of making careful judgments about the definition of a problem. Because analysis is costly, all possible future scenarios cannot be analyzed, and even with careful judgment the analysis may still turn out to be improperly defined Fortunately for B.C. Hydro, the problem was redefined before costly committments had been made.

The third problem with B.C. Hydro's problem definition was a result of the perceptual lens through which the problem was seen. The problem was seen as one of generating supply to meet an expected shortfall through hydroelectric or thermal projects. Several intervenors in the Utilities Commission hearings presented evidence on the possible development of non-conventional energy alternatives as well as pricing schemes (Cooper, 1982; Friends of the Peace, 1982). Non-conventional alternatives such as geothermal power or demand management (by using prices to reduce energy demand, thereby postponing the supply shortfall) were not, however, addressed by B.C. Hydro in its cost-benefit analysis, even though the B.C. Utilities Commission felt that these might have warranted more attention (B.C.U.C., 1983, p. 8). In addition, B.C. Hydro's list of conventional alternatives seemed less than complete. The possibility of constructing other hydroelectric and thermal projects or entering into contingency purchases from industry or other utilities was treated only superficially.

Because B.C. Hydro considered such a limited number of project alternatives, B.C. Hydro's framing of the problem only served to cast doubt upon the objectivity of their analysis. As Fox (1981) has noted,

> . . . the mere fact that Site C may be a better project than Hat Creek does not demonstrate that construction of Site C best serves the public interest. A conclusion based on such a demonstration is comparable in logic to proving that since severing my hand will be less debilitating to me [than] severing my arm, then amputating my hand is in my best interest even though there may be no need to do do (p. 4).

5.2 IDENTIFYING CONSEQUENCES: SPATIAL BOUNDARIES OF THE ANALYSIS

All of the impacts identified in the Site C cost-benefit analysis, in the B.C.U.C. report, and in the proceedings of the review hearings appear to fall within the provincial boundaries of British Columbia. Nowhere in the analysis is mention made of downstream effects beyond the provincial border (see B.C.U.C., 1983; B.C. Hydro, 1980a and 1980b; Lord and Sydneysmith, 1982) although cost-benefit theory tells us that analyses should at least take a national perspective. It is not made clear whether this neglect arises because there are *no* potential impacts in other provinces (primarily Alberta) or because the evaluation of the Site C project was seen only from a provincial perspective. The implications of either of these issues are worth considering in some detail.

Although no mention was made of downstream impacts in Alberta, it is possible that some impacts could occur. The completion of the Bennett Dam on the Peace River in 1967 (located upstream from Site C) did give rise to significant impacts in Alberta's Peace- Athabaska Delta. By 1970 it was becoming apparent that the delta, where the Peace

River joins Lake Athabaska, was drying up. The Peace- Athabaska Delta Project Group was formed to assess these impacts and reported the following changes (among others) in its 1973 report:

- a 36 percent loss of shoreline habitat essential to muskrats and nesting waterfowl;
- a decline in muskrat populations from 250,000 to 17,000 in less than a decade;
- a loss of habitat for bison;
- a decrease in duck production; and
- an increased need for dredging and navigation aids (P.A.D.P.G., 1973, pp. 10-11).

As well, the Group recognized that "the economy of Fort Chipewyan and the lifestyle of its native people have been and continue to be closely linked with the trapping and fishing in the Peace- Athabaska Delta" (p. 11).

Although the Bennett Dam is considerably larger than the proposed Site C project, this evidence of impacts is at least grounds for exploring potential impacts of the Site C project on the Peace- Athabaska Delta. However, it might be argued that the purpose of a cost-benefit study is to take only a provincial perspective as the Canadian *Constitution* Act vests ownership of water resources in the province rather than in the federal government and gives provinces management powers over hydroelectric developments (Sections 109 and 92A(1)(c)).

Percy (1984, p. 87) suggests that "provinces have felt that they could authorize the diversion or pollution of inter-provincial waters with impunity. It seems that such an attitude prevailed at the time of the construction of the Bennett Dam on the Peace River." This attitude developed both from provincial sovereignty over the water resource and from the lack of a binding mechanism in the Canadian constitution to resolve inter-provincial conflicts (in general, see Barton, 1984; Gibson, 1973; Percy, 1984). However, downstream provinces which suffer adverse consequences from the use of water by upstream provinces may still rely on private litigation in the courts.

Two cases in the 1970's indicated a changing interpretation of provincial powers with respect to downstream users. In 1972, the town of Peace River, Alberta brought an action against B.C. Hydro ***(Town of Peace River v. B.C. Hydro)*** for damages caused to the town's water utilities plant as a result of the reduced flow of the Peace River after construction of the Bennett Dam. The case was decided in favor of Alberta, making B.C. Hydro liable for damages The second case affecting inter-provincial waters was ***Interprovincial Cooperatives Ltd. et al. v. The Queen*** (1975). In this case, mercury discharges licenced in Ontario and Saskatchewan entered waters flowing into Manitoba, necessitating the temporary closure of a commercial fishery in Manitoba. Although the fishermen who brought the case to trial were unsuccessful in their court action, there were several dissenting judges who felt that Ontario and Saskatchewan could not validly licence activities in their provinces which had adverse consequences outside of the province.

Because there have been so few cases involving disputes over inter-provincial waters it is difficult to assess what trend the courts will follow in the future. However as one legal analyst notes, "At the very least, the possible trend in law evidenced by these cases must be taken into account by planners of projects which have a significant impact on inter-jurisdictional waters" (Percy, 1983, p. 118).

This preceding discussion demonstrates that there appears to be sufficient reason to explore the possibility of extra-provincial impacts and report on their significance in a cost- benefit study, if only in a qualitative way.

5.3 IDENTIFYING CONSEQUENCES: MEASUREMENT AND PREDICTION

The measurement and prediction of project impacts is a major component of impact assessment and cost-benefit analysis. Two key groups involved in generating estimates of Site C's impacts were B.C. Hydro and provincial government ministries (the Ministries of Agriculture, Environment and Forests). The purpose of this section is to highlight some of the different estimates that arose.

Table 5.1 identified selected physical resource impact estimates produced by B.C. Hydro and the various ministries. The measures selected for comparison were identified in the B.C.U.C. Site C report (1983). Although Table 5.1 is not comprehensive of all the differences that arose, it does provide an example of the nature and magnitude of differences that can arise in an impact assessment. Section 5.6 will show how these different impact measures led to considerably different social cost estimates.

B.C. Hydro and the government ministries differed in their estimates of the amount of flooded land suitable for vegetable production, the area of flooded forest land and the volume of lost timber, the growth in recreation demand, the number of lost hunting days resulting from flooding and the maximum sustainable yield of fish populations in rivers and reservoirs (see Table 5.1). In all of these examples where B.C. Hydro and a government ministry had divergent estimates, the B.C.U.C. determined that the ministries' estimates were more accurate. The only exception to this rule was in the case of fisheries impacts were the Commission decided that neither B.C. Hydro nor the Ministry of Fisheries had sufficient data to accurately predict impacts.

Table 5.1 also reveals that although B.C. Hydro's consultants derived impact measures for lost hunting days and sustainable fishery yields similar to the ministries' estimates, B.C. Hydro did not use these figures as the basis for evaluation, but, instead adopted significantly lower estimates.

The reasons ***why*** these different estimate arose is not addressed here, but the reader is referred to Martin (1985) The Causes ***of Scientific Disputes in Impact Assessment and Management: The Utah Mines Case.***

5.4 OBJECTIVES AND EVALUATION

The objectives to be used for the cost-benefit analysis of the Site C project were defined in the terms of reference for the Utilities Commission by reference to the E.L.U.C. guidelines on social cost-benefit analysis (1977). These guidelines recommend that a

TABLE 5.1

SELECTED PHYSICAL RESOURCE IMPACTS

RESOURCE CATEGORY	B.C. HYDRO	MINISTRY	B.C.U.C.
AGRICULTURE			
-amount of land allocated to high-value vegetable production	80 ha.	400 ha.	400 ha.
FORESTRY			
-lost forest land due to flooding	3824 ha.	1724 ha.	1724 ha.
-decrease in Allowable Annual Cut	8400 per cm.	4736 per cm.	4736 per cm.
GENERAL RECREATION			
-future growth in recreational user days	4% p.a.	1% p.a.	1% p.a.
WILDLIFE & RECREATIONAL HUNTING			
- standing crops of moose deer	125-250 50-250	125-250 50-250	reasonable but need better data base
-loss of hunting days per year	600 (928-2473 est. by consultant)	50-3175	50-3175
FISHERIES			
-maximum sustainable yield in river (# of angling days)	4100-5600 (14000 est. by consultant)	11400-18000	neither can be supported. Hydro did no field work. Ministry had no hard data.
-reservoir yield (# of angling days)	4100-8800 (12000 est. by consultant)	4300-13500	

Sources: B.C.U.C., 1983, pp. 164-167, 175-8, 183-8, 190-6, 199-206.

cost-benefit analysis evaluate efficiency costs and benefits as well as identify the regional distribution of those costs and benefits. The cost-benefit calculations are to be based on efficiencycosts and benefits -- the distributional effects are intended for illustrative purposes only.

Discussion of the validity of the objectives for the Site C project did not seem to arise. The economic efficiency objective was either accepted by all participants in the impact assessment process or these participants were not aware of or concerned with the possibility of modifying the objective function. Discussion about the theoretical limitations of cost-benefit analysis (see Chapter 3.2 and Chapter 4) also did not seem to arise. Participants instead appeared to focus their efforts on debating project justification (energy demand projections), disputing physical resource impacts, or developing different cost/benefit ratios. Thus, throughout the hearing, the robustness of cost-benefit theory itself appeared to be taken for granted or of little concern

5.5 CALCULATION OF PROJECT BENEFITS

A common method of calculating benefits from hydroelectric developments is to "estimate the savings realized by not having to buy from an alternative source" (Prest and Turvey, 1967, p. 180). This alternative source should be the next-least-cost alternative. B.C. Hydro has interpreted this by estimating the savings achieved by not having to build the Hat Creek thermal project. Hat Creek was chosen as the next-least-cost alternative because it was the only alternative identified by B.C. Hydro for the medium demand scenario. Thus, capital, operating and resource costs were calculated for Hat Creek and adjusted to reflect a power generation capacity similar to that of Site C. The sum of these carts is an estimate of the social *benefits* of Site C; they are benefits in the sense of being costs that can be avoided by constructing a different project Ignoring the problem already raised -- that Site C and Hat Creek were not conclusively shown to be the two best alternatives -- at least four additional problems became evident with B.C. Hydro's approach.

First, the E.L.U.C. cost-benefit guidelines recommend the use of willingness-to-pay rather than the alternative-cost method (1977, pp. 19- 20). A study (Lord and Sydneysmith, 1982) commissioned by S.P.E.C. attempted to calculate a WTP estimate for the value of Site C power. Lord and Sydneysmith's estimates range from $288 million to $855 million (with discount rates of 6, 8 and 10%) compared to B.C. Hydro's estimates of $714 million to $1133 million for the same range of discount rates (B.C. Hydro, 1980a p. VII-2).

Secondly, the capital costs, operating costs and resource costs of Hat Creek were calculated to determine the social benefits of Site C. These three costs were not shown in any detail in the cost-benefit document and were not subjected to any sensitivity analysis other than a variation in the discount rate used (B.C. Hydro, 1980a). Because the estimated resource costs of Site C were contested at length during the Utilities Commission hearings (as will be shown later in this report), there is considerable justification for not accepting the social benefits of Site C (which include the resource costs of Hat Creek) as given by B.C. Hydro.

Thirdly, B.C. Hydro's own recognition that it would be difficult to build Hat Creek by the estimated required date of 1987 (B.C. Hydro, 1980a) casts doubt upon the usefulness of a comparison between Site C and a project with a later in-service date. If B.C. Hydro recognized that Hat Creek could not be built within the time frame required, then the analysis should have compared Site C to Hat Creek *plus* additional energy supplied from some other source between 1987 and the year that Hat Creek *would* be completed. No estimate of Hat Creek's "actual" completion date was given in the cost- benefit document.

Fourthly, the energy demand forecasts, or load forecasts, upon which the analysis rests were prepared in 1979. When load forecasts were revised downwards by B.C. Hydro only one year later, Hat Creek, with almost twice the generating capacity of Site C, was no longer a viable alternative. Because no other alternatives had been considered, the cost-benefit analysis of Site C as prepared by B.C. Hydro became meaningless (B.C.U.C., 1983, p. 9) as the measure of Site C's social benefits was now incorrect. In other words, it was likely that Hat Creek was ***not** the* next-least-cost alternative. If this were the case, Site C's benefits would be overstated.

B.C. Hydro's overestimation of energy demand, limited consideration of alternatives and overestimation of project benefits were major problems with its cost-benefit analysis of Site C As a result, the Site C document was either biased or incomplete, or both. The limitations of B.C. Hydro's cost-benefit analysis were recognized in the recommendations of the newly formed Utilities Commission which stated that approval for Site C should be withheld until

> (1) an acceptable forecast demonstrates that construction must begin immediately in order to avoid supply deficiencies and (2) a comparison of alternative feasible system plans demonstrates, from a social benefit-cost point of view, that Site C is the best project to meet the anticipated supply deficiency (B.C.U.C., 1983, pp. 10–11).

Thus, the accuracy of B.C. Hydro's cost-benefit analysis is highly suspect even before their estimation of project costs is considered

5.6 CALCULATION OF PROJECT COSTS: FINANCIAL COSTS

Three types of costs were identified in B.C. Hydro's cost-benefit analysis:

1. financial costs, which are the capital and operating costs of the project;
2. resource costs, or changes in environmental resources (B.C. Hydro calculated *net* costs because some changes were identified as benefits); and
3. regional costs, such as changes in lifestyles or other community attributes.

The capital and operating costs of Site C were estimated and discounted over several discount rates The Utilities Commission concurred with B.C. Hydro's financial cost estimates, agreeing that the project could be built for $1.5 billion ($1980) within a reasonable margin of error (B.C.U.C., 1983, p. 114). However, in its cost-benefit analysis B.C. Hydro did not estimate this margin of error nor test the sensitivity of the cost-benefit results to this margin, even to show that it might have no significant impact on the benefit/cost ratio.

5.7 CALCULATION OF PROJECT COSTS: RESOURCE COSTS

The potential environmental impacts identified by B.C. Hydro included changes in agricultural land, forestry resources, general recreation, hunting, fisheries and heritage resources The following sections will evaluate **Hydro's** treatment of these impacts, review competing estimates of these impacts by various government departments, and compare both estimates to the final values selected by the B.C. Utilities Commission as the most reasonable and accurate.

57.1 Agriculture

B.C. Hydro valued the loss of agricultural land not by calculating the amount of ***actual*** agricultural production that would be lost due to the flooding and disruption of agricultural land but by estimating various scenarios of ***potential*** production which might be foregone. This approach was based on "a presumption, supported by legislation that social value exceeds market value" for agricultural land (B.C. Hydro, **1980a,** p 3-2). In other words, there is some value attached to productive potential even if that potential is not currently being used or demanded. In the context of a hydroelectric development where agricultural land will be lost, this method would produce a higher estimate of project costs than a method based on actual production foregone. Conversely, however, when this potential production method is applied to a hydroelectric project which provides irrigation the result might tend to overstate project benefits if agricultural production levels were constrained by factors other than the availability of irrigation.

Both the Ministry of Agriculture and the Utilities Commission, as well as B.C. Hydro, adopted the "potential production foregone" approach, but their estimates vary considerably (see Table 5.2). Hydro's original estimates ranged from **$2-48** million, depending on the scenario and discount rate used (B.C. Hydro, **1980a,** p. V-27). B.C. Hydro later revised these upward to **$8-52** million, in comparison to the Ministry's

TABLE 5.2

SELECTED EVALUATION ISSUES

RESOURCE CATEGORY	B.C. HYDRO	MINISTRY	B.C.U.C.
AGRICULTURE			
-net annual return on production			
vegetables	$1089/ha.	$3337.5/ha.	$3337.5/ha.
other crops	$ 154/ha.	$ 262.5/ha	$ 262.6/ha.
-rate of increase in crop prices over time	1%	1%	
-rate of increase in economic return	2.5% p.a.	2.5% p.a.	1% p.a.
-TOTAL RESOURCE LOSS	$8-52 mill.[a] $2.4-47.6 mill.[b]	$17.5-94.5 million	$59.8 mill.[c] $24.0 mill.[d]
FORESTRY			
-stumpage value	$4/cubic m.	$6/cubic m.	$6/cubic m.
-value of lost cutting rights	n.e.	$25/cubic m.	$25/cubic m.
-TOTAL RESOURCE LOSS	$.36-1.0 mill.[a] $.33-.9 mill.[b]	$.4-1.1 mill.	$1.0 mill.[c] $0.5 mill.[d]
GENERAL RECREATION			
-recreational value per day	$29.00	$16.60-17.95	$29.00
-river-based recreation value relative to reservoir-based	1.2 to 1.0	1.5 to 1.0	1.5 to 1.0
-TOTAL RESOURCE LOSS	$4-51.6 mill.[a] $3.4-103 mill.[b]	$1.8-3.7 mill.	$6.9 mill.[c] $3.0 mill.[d]

TABLE 5.2 (cont')

RESOURCE CATEGORY	B.C. HYDRO	MINISTRY	B.C.U.C.
WILDLIFE AND RECREATIONAL HUNTING			
-recreational hunting value per day	$32 (WTP)	$64 (WTS)	$32 (WTP)
-non-consumptive value of wildlife	included in gen. rec. est.	= 1/3 of rec. hunting value	agreed with B.C. Hydro
-indirect loss of wildlife	n.e.	$500,000	Should be monitored
-TOTAL RESOURCE LOSS	$.18-1.6 mill.[a] $.19-1.9 mill.[b]	$2.0-3.7 mill.	$2.8 mill.[c] $1.1 mill.[d]
FISHERIES			
-WTP or WTS	WTP	WTS	WTP
-TOTAL RESOURCE LOSS	$.3-10 mill.[a] $8.9 mill. loss to $4.8 mill. gain.[b]	$2-4.2 mill.	insufficient data. cannot be determined.

Table Notes:

a. 1983 estimate. Source: B.C.U.C., 1983
b. 1980 estimate. Source: B.C. Hydro, 1980a
c. estimate discounted with hybrid approach
d. estimate discounted at 8%
n.e. not estimated

Sources: B.C.U.C., 1983, pp. 164-7, 175-8, 183-8, 190-6, 199-206.
B.C. Hydro, 1980a, pp. V-9, V-12, V-16, V-27, V-29.

estimates of $15.5–94.5 million. These contrast with the final estimate adopted by the Utilities Commission of $59.8 million.

The evaluation approaches of B.C. Hydro, the Ministry of Agriculture and the Utilities Commission fail to take into account several concerns raised by intervenors during the Utilities Commission hearings (see, for example, Fox, 1980; B.C.U.C., 1983, p. 168). One concern raised was that valuing agricultural resource losses by potential production foregone fails to adequately reflect the land price effect of the Agricultural Land Reserve system in B.C., of which the Site C lands are a part Fox (1980, pp. 14– 5) argues that commercial land in the Lower Mainland of B.C. sells for five to ten times the price of agricultural land which is protected under the Agricultural Land Reserve system. This implies that shadow pricing could be applied to the lands affected by Site C using this approach and the results compared with the "production foregone" valuation approach. In Fox's estimation, "The Agricultural Land Reserves Act has clearly established a policy which recognizes values in agricultural land that are many times the values based on the value of agricultural products" (Fox, 1980, p. 17).

Other intervenors wished to see an option value attached to agricultural land to reflect future increases in agricultural land values in the event of significant world food shortages. The Commission felt that such values could not be "meaningfully quantified" and opted instead to stress the importance of compensation programs "designed to improve and intensify agricultural production" (B.C.U.C., 1983, p. 169).

5.7.2 **Forestry**

The flooding or disturbance of forest land . in B.C. is also a special case which cannot be valued by traditional market pricing because the majority of forest lands are owned by the provincial government, They therefore have no established market prices. Valuing impacts to forest lands must instead be done by calculating the loss of sustained yield (long term) timber production, called the "allowable cut effect" Because of the allowable cut effect, the value of lost timber is not equal to the stumpage value of the standing timber but is instead measured by its contribution to the long-term sustained timber yield of an area.

B.C. Hydro and the Ministry of Forests varied somewhat in their approach to evaluation, with Hydro using lower stumpage values but applying them to a land base almost twice as great as that used by the Ministry. The net loss figures calculated by each were therefore very similar (see Table 5.2) but based on very different assumptions. The Utilities Commission adopted both the stumpage values and the land base figures provided by the Ministry of Forests (see Table 5.2).

An additional argument presented by B.C. Hydro, but discredited by the Utilities Commission, claimed that because the affected lands in the Site C area were not presently economically recoverable, the actual forest resource loss "would be near zero" (B.C. Hydro, 1980a, p. V-28). This argument was rejected because it fails to consider that the future value of the forest lands might increase as more economical sources become scarce.

The approach taken by B.C. Hydro, the Ministry of Forests and the Utilities Commission does not recognize the value of forested land for anything other than timber production. This issue will be discussed together with the evaluation issues of hunting and trapping later in this report

5.7.3 General Recreation

In this category, B.C. Hydro included the value of lost river recreation based on a WTP approach and the value of "non-consumptive" uses of wildlife and wilderness resources. Because the construction of a darn provides increased reservoir recreation but decreased river recreation, the net impact on recreation opportunities depends on the difference in value between reservoir and river recreation While B.C. Hydro stated that it had made calculations based on the assumption that river recreation ranged from unity to

1.5 times as valuable as reservoir recreation, the data B.C. Hydro presented in its cost-benefit analysis reflected only the assumption that river recreation was 1.2 times as valuable. In contrast to B.C. Hydro's approach, the Ministry of Lands, Parks and Housing assumed that river recreation was 1.5 times as valuable as reservoir recreation. The Ministry, however, assumed that general recreation was valued by individuals at $16-18 per day, compared to B.C. Hydro's estimate of $29 per day. The Utilities Commission adopted both the higher river recreation value and the higher WTP value (see Table 5.2 for results).

In general, B.C. Hydro's treatment of recreation benefits is not well documented in the cost-benefit statement. Recreation benefits are aggregated and no indication of the value of non-consumptive types of recreation is given, although Hydro later clarified this during the course of the Utilties Commission hearings.

During those hearings, both B.C. Hydro and the Ministry of Environment agreed that the non-consumptive value of wildlife was equal to one-third of the hunting value of wildlife. This valuation overcomes to some extent the limitation of a Clawson-type approach to valuation which has been criticized as valuing wildlife "as if their main value is to be stalked and killed by sportsmen" (McAllister, 1980, p. 131).

5.7.4 Hunting and Trapping

In valuing hunting and trapping impacts, B.C. Hydro made several assumptions which were contested during the B.C. Utilities Commission hearings. The first was the willigness-to-pay approach used in B.C. Hydro's evaluation and accepted by the Utilities Commission. The Ministry of Environment used a willingness- to-be-compensated (or willingness-to-sell) approach, which gave a resource value twice as high as the WTP approach (see Table 5.2).

The second assumption used by Hydro was a presumption that losses in hunting and trapping potential are directly proportional to the loss in land area. This assumption was somewhat borne out by trappers' claims that the 6 percent loss in area would create no more than a 10 percent reduction in trapping capacity (B.C.U.C., 1983, p. 191).

The third assumption was a neglect of the value of lost enhancement potential on the grounds that there were "no specific plans for wildlife enhancement and no assured-future demand for the increased stock" (B.C.U.C., 1983, p. 190). The Ministry of Environment did have enhancement plans, and the Utilities Commission agreed that lost enhancement potential should be included in the valuation of resource losses. B.C. Hydro's argument points out some inconsistencies in its resource evaluation approach in general. While B.C. Hydro accepted the evaluation of forestry losses and agricultural losses based on production *potential* without considering actual levels of future demand, it was more unwilling to recognize lost potential of a non-economic resource.

The fourth assumption used by B.C. Hydro and not challenged by the Utilities Commission was its neglect of uses of forest and wilderness areas for activities other than timber production, hunting and trapping, and non-consumptive use of wildlife. Other uses of forest land mentioned by intervenors included its values "for wildlife, recreation, fuel and as a climate modifier" (B.C.U.C., 1983, p. 178); other uses might include scientific study or ecological uses.

5.7.5 Fisheries

B.C. Hydro estimated that the net impact on fishing opportunities in the Site C area ranged from a loss of $300,000 to $2.0 million. (see Table 5.2). In contrast the Ministry of Environment estimated resource losses of $2-4 million. The evaluation of fishery impacts remained unresolved at the end of the Utilities Commission hearings. Disputes centered on estimates of maximum sustainable yield in the reservoir and estimates of demand Hydro's calculations showed that the Site C project would enhance angling days by almost 50 percent while the Ministry of Environment's calculations determined that angling days would decline by 25 percent The differences in this assumption largely accounted for the different estimates produced by B.C. Hydro and the Ministry. As an example of how sensitive this assumption is to the interest rate use, when a 3 percent discount factor is applied, B.C. Hydro's assumption results in resource losses ranging from $8.9 million to a resource *gain* of $4.9 million (B.C. Hydro, 1980a, p. 5-9). The Utilities Commission concluded that neither B.C. Hydro nor the Ministry of Environment had sufficient data upon which to base an evaluation of fishery impacts and charged them both with the responsibility of further study (B.C.U.C., 1983, pp. 203-4). In general, the Utilities Commission agreed with the evaluation parameters used by the Ministry of Environment except for the Ministry's use of WTS rather than WTP as the basis for evaluation.

5.8 CALCULATION OF PROJECT COSTS: REGIONAL COSTS

Regional impacts were presented in B.C. Hydro's cost-benefit statement but they suffer from a lack of documentation. Impacts on physical infrastructure, relocation of families, community stability and social infrastructure were assigned a significance level ranging from one to three with no additional information or description given. Although additional information was available in B.C. Hydro's *Environmental Impact Statement*, no mention was made of this in the cost-benefit statement

During the Utilities Commission hearings, more detailed evidence of regional social impacts was presented The four issues which were addressed were: (i) resident versus non-resident employment, (ii) community impacts, (iii) health service impacts, and (iv) impacts to native communities. None of these considerations was explicitly incorporated into the Site C cost-benefit calculations, but the Commission did make recommendations concerning their treatment.

Because the distribution of project benefits depends to a large extent upon the amount of local hiring, the B.C.U.C. recommended local hiring programs to be administered by B.C. Hydro (B.C.U.C., 1983, pp. 224–225). The Commission also dealt with requests for compensation by four local Peace River communities by recommending a compensation package for Fort St. John, Hudson Hope and the Peace–Liard Regional District based on a monitoring program. The Commission turned down the town of Taylor's request for compensation and turned down a request from the Peace–Liard Regional District for intangible costs (B.C.U.C., 1983, pp. 229-237). The Utilities Commission also recommended a monitoring program for impacts to native communities (pp. 240–246) with three restrictions: (i) compensation should be in *kind* rather direct cash payments to natives; (ii) monetary compensation should be used to develop compensation schemes in conjunction with native input; and (iii) compensation should not be based on cumulative impact of various developments on the native subsistence economy but should relate specifically to Site C impacts only.

5.9 THE EVALUATION OF INTANGIBLE PROJECT IMPACTS

B.C. Hydro recognized several intangible resource impacts in its cost-benefit statement. The major impact discussed was to heritage resources, for which Hydro had "no satisfactory method for suggesting even an approximation to value" (B.C. Hydro, 1980a, p. III-S). Both B.C. Hydro and the Utilities Commission deemed appropriate a cost-sharing recovery program that would make Hydro responsible for up to $1.1 million and the province responsible for up to $500,000. Implicitly, then, one might assume that the value of the intangible heritage resource was at least equal to $1.6 million. This issue did not appear to be highly contested during the Utilites Commission hearings.

The other intangible resource impacts mentioned in B.C. Hydro's cost-benefit statement were impacts on air quality, water quality and climatic effects In little more than one sentence B.C. Hydro mentioned "unquantifiable visual, aesthetic and relocation impacts" (1980a, p. W-9) but failed to elaborate in any way other than to provide a table listing the relative significance of these impacts; description is entirely lacking (see B.C. Hydro, 1980a). Although additional information could be found in Hydro's *Environmental Impact Statement* for Site C (1980b), any reference to this document was missing in the discussion of intangible impacts.

Hydro's treatment of these intangible resources tends to lead to the conclusion that "unquantifiable" resources are synonymous with "undescribable" resources. We must question why, if B.C. Hydro felt that "benefits and costs which can be quantified are often the least controversial aspect of project analysis" (1980a, p. VII- 9), readers are not given more information on the supposedly more controversial intangible resources. Of course, from the evidence presented at the Utilities Commission hearings, it seems that it was the *quantifiable* impacts which proved to be the most controversial.

5.10 THE DEBATE OVER WILLINGNESS TO PAY VS. WILLINGNESS TO BE COMPENSATED

B.C. Hydro adopted a willingness-to-pay approach for all of its resource valuations. During the Utilities Commission hearings it became evident that the Ministry of Environment used willingness-* be-compensated, or willingness-to-sell, figures for lost access to recreational resouces on Crown land. B.C. Hydro itself recognized that recreation on Crown lands may be considered an "inalienable public right" (1980a, p. VII- 8). Because the use of WTP vs. WTS turns on the assignment of rights, one might have thought that B.C. Hydro would have agreed with the use of WTS figures for such resources.

In contrast, the Utilities Commission denied this notion of any inalienable right of private citizens with respect to Crown resource losses based on the argument that values should measure worth to the province as a *whole* and not to any special group of users (1983, p. 148). But it is not clear how this argument supports the use of WTP over WTS. In the Commission's estimation, only WTP calculations are correct This decision by the Utilities Commission may portend future debate over the blanket adoption of WTP measures in light of the 1977 Cost-benefit Guidelines published by the provincial government's Environment and Land Use Committee which suggest that WTS should be used to evaluate such natural resource losses.

The only exception to the WTP approach recognized by the Utilities Commission applies to impacts suffered by native indians. For native indians, WTS should be used "in the case of impacts on native Indian rights under treaty" (B.C.U.C., 1983, p. 148).

5.11 THE CHOICE OF A DISCOUNT RATE

In its choice of a discount rate, B.C. Hydro calculated its social opportunity cost of capital as 6 percent based on the availability of provincial trusteed funds at 3 percent For purposes of sensitivity testing, B.C. Hydro adopted discount rates of 3, 6 and 10 percent

There was a fair amount of debate during the Utilities Commission hearings over the selection of an appropriate disocunt rate. Fox (1981) argued that B.C. Hydro's estimate of the social opportunity cost of capital (SOCC) was inaccurately determined because it was based on a subsidized rate on trusteed funds given to Crown agencies (such as B.C. Hydro) at the expense of pensioners. The true SOCC would therefore be greater than 6 percent. Lord and Sydneysmith (1982) claimed that 6 percent was the lowest plausible discount rate and recognized that there were arguments to support an even higher rate. The Environment and Land Use Committee guidelines suggest using discount rates of 8, 10 and 12 percent if a true SOCC can't be determined. Treasury Board Canada (1976) guidelines recommend 5, 10 and 15 percent.

Ultimately, the Utilities Commission decided on a hybrid approach to discounting in which (i) a 3 percent discount rate would apply to resource costs and benefits (based on the long term risk-free government bond rate equalling the SRTP), and (ii) an 8 percent discount rate would apply to investment cash flows (based on their estimate of the

SOCC). The Utilities Commission approach appears consistent with the method advocated by Pearce (1983), but should not neglect the benefits afforded by some amount of sensitivity testing on the SRTP and/or the SOCC.

5.12 A SUMMARY OF BENEFIT AND COST ESTIMATES

Table 5.3 summarizes the benefit and cost estimates that emerged during the B.C. Utilities Commission Site C hearings for a range of discount rates. The cost/benefit ratios put forward ranged from 0.39 to 1.58. The Utilities Commission, in its report of recommendations (1983), did not produce final cost/benefit ratios for Site C because B.C. Hydro had not correctly estimated project benefits and because fishery impacts had not been accurately determined by B.C. Hydro or the Ministry.

It is possible, however, to derive approximate benefit/cost measures for Site C based on the best information available at the end of the B.C.U.C. hearings. These are presented in Table 5.4. Discount rates of 6, 8 and 10% were chosen as there seemed to be a consensus among participants that 6% was the lowest possible rate. These discount factors were applied to project benefits and capital costs. Because B.C. Hydro's benefit estimates were determined to be incorrect, the only other benefit estimates available were those calculated by Lord and Sydneysmith (1982). These are shown in Table 5.4. Both B.C. Hydro (1980a) and Lord and Sydneysmith (1982) agreed on the present value of capital and operating costs; the B.C.U.C. did not appear to contest these.

The resource costs used in Table 5.4 are based upon the recommendations of the B.C.U.C. Both the present values based upon the hybrid discounting approach and an, 8 percent rate are shown. However, these resource costs exclude the value of fishery impacts as the Utilities Commission determined there was insuffkient data on which to base an evaluation. The resulting benefit/cost ratios shown in Table 5.4, therefore, represent the best available information but exclude fishery impacts. The benefit/cost ratios range from 0.37 to 0.95 over the range of discount rates.

TABLE 5.3

A COMPARISON OF BENEFIT AND COST ESTIMATES
FOR SITE C

DISCOUNT RATE	P.V. Benefits	P.V. Capital costs	P.V. Resource costs	C/B Ratio
3%				
B.C. Hydro	1924.7	1052.8	162.1	1.58
6%				
B.C. Hydro	1133.1	870.3	49.6	1.23
Lord & Sydneysmith	855	870	50	0.93
8%				
Lord & Sydneysmith	481	770	25	0.61
B.C.U.C.	n.e.		28.6	n.e.
10%				
B.C. Hydro	714.6	712.8	17.1	0.98
Lord & Sydneysmith	288.0	713	17	0.39
Hybrid[a]				
B.C.U.C.	n.e.		70.5[b]	

Table Notes:

a. Hybrid discounting approach recommended by the B.C.U.C. for resource costs

b. Excludes fishery resource impacts.

Sources: B.C. Hydro, 1980a; Lord & Sydneysmith, 1982; B.C.U.C., 1983.

TABLE 5.4

ESTIMATED BENEFIT/COST RATIOS
FOR SITE C

DISCOUNT RATE	P.V. BENEFITS	P.V. CAPITAL COSTS	P.V. RESOURCE COSTS		C/B RATIO	
			Hybrid	8%	Hybrid	8%
6%	855	870	70.5	28.6	0.91	0.95
8%	481	770	70.5	28.6	0.57	0.60
10%	288	713	70.5	28.6	0.37	0.39

6.0 A SUMMARY OF UNCERTAINTY IN COST-BENEFIT ANALYSIS

The preceding chapters have identified three fundamental problems that face cost-benefit analysis:

1. A single estimate of a project's benefits and costs is difficult to calculate:

   a). because of commonly recognized types of uncertainty, such as

   - uncertainty about project impacts (predictive uncertainty) (Chapter 3.4)

   - uncertainty about the application of evaluation techniques (evaluative uncertainty) such as the selection of a discount rate and valuing non-market resources (Chapter 4.1).

   b). because of less frequently recognized types of uncertainty, including

   - differences in problem definition (conceptual uncertainty) (Chapter 3.1)

   - problems with defining objectives for evaluation -- Arrow's Impossibility Theorem (ethical uncertainty) (Chapter 3.2.5)

   - difficulties with the identification of alternatives (factual uncertainty) (Chapter 3.3).

2. Benefit and cost estimates might not be meaningful:

   a). because of neglected elements in many CBA's, such as

   - option values

   - irreversibility

   - risk

   - non-utilitarian principles

   - preferences of future generations

   - preferences of non-users. (Chapter 4.1).

   b). because of problems with cost-benefit methodology, specifically

   - the theory of second best

   - the Scitovsky reversal paradox. (Chapter 3.2).

3. Benefit and cost estimates are not value free:

   a). because value judgments must be made (Chapter 4.2.1).

b). because cost-benefit analysis cannot reflect all moral principles (Chapter 4.2.2).

The most commonly noted reasons that single cost-benefit estimates cannot be determined are uncertainty about project impacts, the existence of non-market resources and **unquantifiable** impacts, and the selection of a discount rate. Uncertainty about these factors is usually dealt with in CBA by using multiple discount rates and multiple impact measures. The resulting analysis is comprised of multiple estimates of net benefits or benefit/cost ratios. When multiple estimates for each project exist, it may be impossible to decide with certainty that a project's benefits outweigh its costs (although some projects may be less affected by this type of uncertainty because the magnitude of their benefits clearly outweighs the costs, regardless of the uncertainty. This uncertainty is more critical for borderline projects).

Less frequently **recognized** sources of uncertainty in cost-benefit analysis include conceptual, ethical and factual uncertainty. Firstly, a problem might not have been appropriately defined, it might be difficult to define (a "wicked problem"), or people may not agree on the problem definition. Regardless of the nature of the problem at hand, the existence of Arrow's Impossibility Theorem creates uncertainty about the universality of any defined set of objectives. Different problem definitions affect the selection of appropriate alternatives.

A cost-benefit analysis might not be meaningful because the analysis has neglected certain elements. Among the more common missing elements are: i) the preferences of non-users; ii) option values; iii) irreversibility; iv) high magnitude, low probability risks; v) the preferences reflected in non-utilitarian principles; and vi) the preferences of future generations

Even in a more certain world -- where only one problem formulation exists, where a set of objectives could be unambiguously defined, where alternatives could be clearly identified, where uncertain impacts did not exist and where all impacts could be quantified -- cost and benefit estimates still might not be meaningful. Cost-benefit analysis is plagued by ambiguities which threaten the achievement of objectives. The objective which has received the most attention is that of economic efficiency. The theory of "second best," the Scitovsky reversal paradox, the need for actual rather than potential compensation under certain conditions, and the possibility of a Prisoner's Dilemma all make the achievement of the economic efficiency objective suspect That is, these paradoxes and dilemmas suggest that even comprehensive and certain cost and benefit estimates are no guarantee that objectives will *actually* be achieved

All of these factors threaten to make cost and benefit estimates meaningless. As Downs and Larkey note (1986, p. 127),

> The analysis is not apt ever to become a sufficient decision procedure, and as long as the problems with single alternatives, predictive accuracy, and excluded values persist, worrying about the precise niceties of criteria [such as benefit/cost ratios of net benefits] is like "optimizing the arrangement of deck chairs on the Titanic rather than watching for icebergs."

Any cost-benefit analysis, no matter how carefully done, contains value judgments. These value judgments occur in all phases of the analysis, whether problem formulation, objective definition, alternative selection, impact identification, or evaluation. For example, how a problem is defined will depend on who is defining it Objectives also require value judgments as they only have meaning in relation to desired ends, and "the nature of the objective depends entirely upon the value judgments of the person stipulating it" (Winch, 1971, p. 25). Value judgments also enter an analysis at the prediction phase, where assumptions must be made about the types of hypotheses to test, variables to measure and data to collect.

The underlying criteria of cost-benefit analysis, that total benefits should exceed total costs (the Hicks-Kaldor rule) is based on a value judgment that some people might wish to alter. For example, one might want to modify this rule by requiring that compensation to those who suffer losses actually take place or by restricting the amount or types of involuntary risks that can be imposed on the individuals in society. One of these criteria could only be judged better than another by reference to value judgments. Cost- benefit analysis also may require judgments to be made about the desirability of an income distribution or about the specification of deservingness weights for individuals, groups or regions. It also implicitly ignores, and therefore makes a value judgment about, the preferences of future generations and of people holding non-consequentialist moral principles. Similarly, the practice of valuing resources with willingness-to-pay estimates rather than willingness-to-sell may hide assumptions being made about the types of rights that individuals in a society may have.

Because of these three fundamental problems with CBA, competing analyses arise and have some claims to validity. Arguments that develop over analysis should be expected rather than unexpected events. It is unlikely that cost-benefit analysis can ever give one answer to a problem as long as individuals pursue different goals, have different preferences and principles, and perceive the world differently. The role of cost-benefit analysis should therefore not be to decide but to illuminate. It can never (except in extremely simple situations) be the sole method for reaching a decision when society at large is involved

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