INTEGRATING ECONOMICS AND EIA: Institutional Design and Analytical Tools

Peter K. Stokoe

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FOREWORD

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The Secretariat
13th Floor, Fontaine Building
200 Sacré-Coeur Blvd.
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K1A OH3

Tel.: (819) 997-l 000
Fax. : (819) 953-2534

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1. INTRODUCTION

This Background Paper develops, and draws implications from,-an economic interpretation of the function of environmental assessment and other policy instruments in instituting an environmentally-sustainable economy. This is an economic interpretation because it considers environmental assessment and other emerging instruments as means for incorporating environmental values into economic decision-making. Environmental assessment processes are sometimes expanded to take into account broader social and cultural values through what is sometimes called social impact assessment. The focus herein will be on environmental values. From the perspective developed in this Paper, it begins to become clearer how economics and environmental assessment, and environmental impact assessment (EIA) in particular, can be integrated into an overall framework for the assessment of projects, programs and policies.

It is indicative of the pace of modern change that it has only been twenty-five years since "the environment" arose as a general concern and yet today, it is arguably the leading global issue. Nevertheless, the implicit understanding in economic theory of what we now call "the environment" has been evolving over the past two hundreds years and, in particular, with increasing rapidity over the past 30 years.

For a long period from its beginnings in the eighteenth century, the mainstream of modern economics (classical and neo-classical economics) viewed the material world primarily as the source of extractive resources for the production process. It was only with the advent of the first major conservation movements, around the turn of the 20th century, that economics began to acknowledge that the material world could also be a source of amenity services. Consequently, it came to be considered that economic choices must be made where incompatibilities arise between uses of the material world as a source of extractive resources and as a source of amenity services. Following on from this came the recognition of further possible incompatibilities between these uses and the use of the material world as a receptacle of wastes from production and consumption, the physical environment having a limited "assimilative capacity" (Fisher and Peterson 1976), or more generally, taking into account all three uses, a limited "carrying capacity".

Even at the beginnings of modern environmental awareness, the economy was considered to be autonomous from the environment in the sense that exceeding any environmental constraint was reversible by human action or natural processes and therefore, in principle, only a temporary inconvenience. Only recently has it been fully acknowledged that economic development can generate cumulative and irreversible environmental damage such as the accumulation of persistent chemical and radioactive contaminants, climate change and species extinction. At the same time, there has been a growing awareness of the environment as a dynamic system -- an ecosystem -- with which the economic system interacts even as a subsystem. Many today recognize that the two systems are interdependent and co-evolve, and share a common fate (Boulding 1981; Norgaard 1985, 1987; World Commission on Environment and Development 1987). This has become especially evident in the intricate and fragile ecosystems of the tropics and subtropics.

Economic theory has only just begun to catch up with this new understanding. At the same time, economic theory does already provide some insight into the functioning and misfunctioning within an economy which can lead to environmental and resource degradation. The theory has also led to the development of analytical tools that can help in taking account and weighing overall, short-term consequences in policy and planning. Both the underlying theory and the analytical tools need to be revised and supplemented according to the new understanding of economy-ecosystem interdependence. This, however, has not yet been accomplished in a systematic way.

Meanwhile, new institutions are being established to cope with the environmental consequences of economic activity. These new institutions, including EIA, arose as more or less spontaneous responses to concern about environmental costs that were not being adequately considered in planning. To the extent that these environmental costs should have the same status as other costs in economic decision-making, the new institutions already have some economic rationale and justification.

If, however, we take these environmental costs as givens, we may limit ourselves to considering only the symptoms, and not the causes, of environmental harm. This Paper takes the view that by giving attention to the causes of environmental harm recognized in economic theory, new institutions can be designed to be more effective in addressing these causes. One of the ways that economic theory can help in making these institu-

tions more effective is by explicitly recognising and encouraging the growing complementarity among them. In this way, economics carries on its original vocation of helping to guide the evolution of institutions and policy to better meet human needs and purposes (although to do this, it may have to recognize previously unacknowledged needs and purposes).

Within such an institutional framework for environmental sustainability, analytical tools can then be developed to assess consequences and evaluate alternatives in terms of the recognized values. Understanding the overall institutional framework for environmental sustainability is primary, because the appropriateness of a tool depends on where and how it is used within the framework.

In accord with these considerations, the main body of this Background Paper begins with a brief, non-technical review of current economic theory as it relates to the environment. The institutions that are emerging and evolving to cope with the economic causes of environmental harm are then noted, with a view to their interrelationships within an institutional framework for environmental sustainability, and especially their relationships with EIA. Attention is then turned to analytical tools, including predictive and evaluative tools. A survey of predictive tools that might be adapted to find appropriate application within an institutional framework for environmental sustainability ensues. Next, possible adaptations of evaluative tools, especially cost-benefit analysis, for application within such a framework are considered. Finally, some conclusions and recommendations regarding institutional design and analytical tools for EIA are outlined. The references cited throughout the text provide a broad survey of the recent literature in environmental economics.

This Background Paper is addressed to EIA practitioners, economists concerned with the environment, and policy-makers who contribute to the evolution of institutions that are intended to recognize environmental values. It is assumed that readers are acquainted with the basic terminologies of environmental assessment and management, and of sustainable development. For each of these groups, there may be parts of the paper which appear trivial in terms of their own perspectives. Nevertheless, for all of these groups, the paper is intended to suggest directions in which the practice and development of EIA and other institutions and the perspectives and analytical methods of economics can be productively reconciled. Such a reconciliation is neither immanent nor assured. The directions indicated here are merely suggested as the most promising for this purpose. It may require a degree of mutual faith to explore some distance in these directions before the shape of a possible reconciliation can begin to be discerned. This paper can be taken as an extended invitation in this spirit to join this exploration. As a Background Paper and document for discussion, it is intended to be more provocative than definitive.

2. ELEMENTS OF ENVIRONMENTAL ECONOMICS

In order to better reconcile environmental and economic considerations into a broader policy and planning framework, the starting point here will be an understanding of the current status of the environment in economics. Imparting this understanding is problematical, however, because economic theory is ambiguous even about what constitutes "the economy".

Three Economies: the Origin of Externalities

In its narrowest sense in economic theory, "the economy" is the linear process of production of commodities and services by firms, distribution of commodities usually through markets and consumption of commodities and services. Firms pay consumers for labour and other inputs to production and distribution they own, and consumers pay firms for commodities and services. There are thus circular flows of commodities, services, labour and other inputs in one direction and of money in the opposite direction. "The economy," in this narrow sense, will be called Economy 1 or the **Market Economy (see** Figure 1). The core of mainstream economic theory, neoclassical economics, is a theory of how Economy 1 works. In principle, this theory can be rigorously quantitative, because the whole process is mediated by money, which provides a consistent metric.

Taking a somewhat broader view, it can be recognized that "production" of commodities and services also takes place within households for internal consumption, without the mediation of a market. Indeed, it was this internal household production which was originally the exclusive concern of "economics" (as indicated by the etymology of the word from the Greek *oikonomia* meaning management of a household, which was the scope of the concern in the works of Aristotle, for example). Clearly, the commodities and services produced within households are just as important for economic well-being as commodities and services bought outside. Indeed, many commodities bought outside are only intermediate products which are used within households to produce commodities and services for final consumption (Burns 1977). Households sometimes derive resources directly from the environment for subsistence, especially in less industrial ized economies. Beyond individual households, there are also many voluntary, non-profit and cooperative organizations and informal or barter economies within the community producing goods and services that contribute directly to well-being (Nicholls and Dyson 1983).

Firms provide their employees not only wages, but also work "communities" offering various degrees of safety, comfort, stress, status, security, work satisfaction, fulfillment and other "services". In this sense, firms can also be said to derive *amenities* from the environment for their employees -- and for their customers in the case of the tourism and recreation sector, for example.

Governments also perform various functions in the economy. They provide an institutional structure of rights and liabilities, facilitating the operation of the market economy. They deliver services to firms and households both directly and indirectly through the provision of infrastructure. They grant subsidies to firms and transfer payments to households. Finally, they collect taxes, mainly on incomes and expenditures, to finance these varied operations.

Many goods and services are not inherently limited to provision by governments, firms, community organizations or households, but can be provided by more than one of these kinds of organizations. One can even consider there to be a kind of price competition among these organizations for the favour of consumers/voters in the delivery of these goods and services (Breton 1989).

When we consider the size and scope of operations of firms, governments, community organizations and households in the provision of well-being, we encompass a broader view of the economy, which we can call Economy 2, or the **Political Economy.**

Economists also recognize that organizations and people can contribute or detract from each other's production possibilities or conditions of well-being not only through the commodities and services they intentionally produce but also through the incidental effects of their production and consumption activities. If there is no price mechanism to moderate their production of these effects taking into account costs or benefits for others (as there is in the case of the production of commodities and services in the market), they may produce too much (or too little) in terms of overall costs and benefits to everyone. In particular, such effects may include interference with "environmental functions" (de Groot 1986) that contribute directly to human life and livelihood. Such incidental effects may in general result

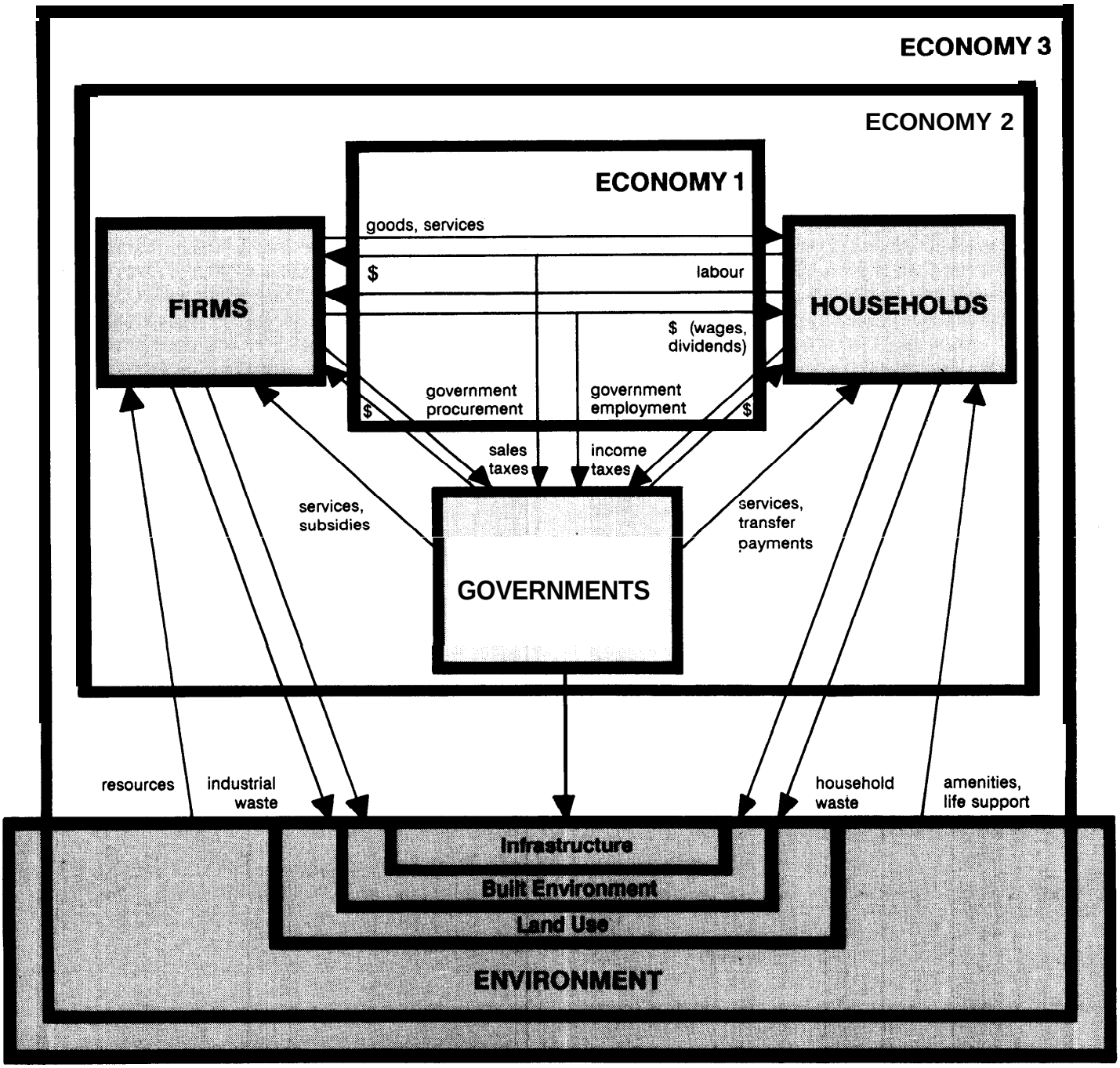

Figure 1. The three economies

in benefits or costs to other producers and consumers and are hence called positive or negative "externalities" (Mishan 1971 b) respectively.

A typical kind of externality involves the natural environment. The paradigm case is pollution, where a factory emits waste into water or air, which detracts from the benefits gained from that water or air by others. However, industries can also generate positive environmental externalities. An example of this is the maintenance of a growing forest which can also serve as a wildlife habitat and a place for recreation (Bowes and Krutilla 1985). Firms, governments and households can also generate externalities through modifications of the environment with infrastructure, buildings and land uses generally.

In practice, an externality can be socio-economic as well as environmental. A common example of this is where an industry in a one-industry town may close without regard to the unexpected costs this imposes on residents of the town. Whether the effect is strictly environmental or more generally socio-economic, it can be seen that this notion of externality corresponds quite closely to what is recognized as an "environmental effect" in environmental law and in EIA.

When we take into account the environment as a source of natural resources, amenities and life support, and as a medium through which externalities are transmitted, we encompass a still larger economy, which we can call Economy 3, or the **Embedded Economy.** Note, however, that this is still a strictly anthropocentric view of the environment, reducing it to the medium through which economic actors can have incidental effects on each other.

From an economic perspective, EIA is precisely the investigation and "assessment" (if not evaluation) of externalities. Indeed, EIA often includes the investigation of potential sócio-economic, as well as environmental, externalities. Hitherto, EIA has applied mainly to governments' infrastructure projects, but it could also apply to government policies. Some forms of EIA or environmental auditing can also apply to firms and even households. In general, however, EIA is only one kind of environmental measure applicable to firms and households.

A special case of an economic externality occurs where there is a resource (e.g. a fishery) with open, unrestricted access. In this case, everyone with access to the resource can use or harvest it to the point where the individual benefit of a further increment of extraction begins to fall below the cost of extraction for this increment. This generally results in an overall level of resource use beyond the point where total benefit to everyone is greatest. It can also lead to severe depletion or degradation of a resource, or even extinction of a species.

Corresponding to its diagnosis of environmental problems as "negative externalities", economics offers various remedies.

- One remedy is for the government to impose a charge or tax to provide an incentive to reduce the externality to a point where the difference between the social benefits of externality reduction and the technical costs of externality reduction are maximized (Pigou 1960; Baumol and Oates 1975).

- Another approach is to sell property rights to this "optimal" level of externality; if each organization must "buy" such rights according to the level of externality it generates, each will again have an incentive to reduce its level of externality appropriately.

Economists generally refer to the creation of such incentives to reduce an externality to an appropriate level as "internalization" of the externality, because the social costs of the externality are then represented by real, monetary costs in the internal accounts of the organization, and influence the organization's decisions accordingly. Nevertheless, in practice, governments have tended to favour approaches to the control of environmental externalities which rely more on emission or technology standards, or regulations with fines as penalties for non-compliance.

Assignment of property rights is also promoted as an approach to deal with the open access, resource problem. It is argued that if such rights are assured, owners will be more inclined to conserve (i.e. maintain the resource) because they are assured of reaping the future benefits of such conservation. Indeed, in an influential article that first appeared twenty years ago, the ecologist Garrett Hardin suggested that "mutual coercion mutually agreed upon" was usually the solution that was forced to the "tragedy of the commons" (Hardin 1968), as he named the phenomenon, referring to the historical case of the degradation of some of the common lands in England prior to their enclosure under private ownership. Of course, the Enclosure Movement was not much of a

"solution" for those people who were displaced from the land; perhaps it could appear so in this case only because there were growing opportunities for the displaced to work in new industrial activities or to emigrate to colonies in the New World and elsewhere. More generally, however, enclosure can simply transfer the problem elsewhere, as in many developing countries today, where the displaced become the underemployed residents of shantytowns surrounding the large cities or subsistence farmers on marginal land which becomes subject to severe soil erosion and hazards from landslides and flooding (Eckholm 1976; Pearce 1988a; Southgate and Pearce 1987).

It is increasingly being recognized that a wide variety of institutional arrangements have been, and are, available for limiting access and jointly managing "common property" resources (Ciriacy-Wantrup and Bishop 1975; Ruskin 1986; Regier and Baskerville 1986; Ostrom 1987; Pearce 1988a). Indeed, with regard to Hardin's example, it is now recognized that it was the breakdown of such traditional arrangements that originally led to degradation of some of England's common lands (Cox 1985).

Institutional arrangements may also be available for the control of externalities. To the extent that people can show that they have been harmed by the conduct of others, they may have remedies through the common law of torts and negligence which forces the agents of the harm to internalize some costs. The common law is gradually being expanded with varying effectiveness to cover new causes of environmental hazards (Stewart and Krier 1978; Schrecker 1984).

Coase (1960) claimed that, as long as the law makes any clear initial assignment of rights between a polluter to pollute or a pollutee to be free from pollution, polluter and pollutee could in principle negotiate to exchange those rights for payments to a point where a mutually acceptable level of pollution and payments is achieved. As long as the polluter and pollutee are free to bargain, this settlement would be "efficient" in economic terms, because again the costs of pollution would be internalized by the polluter as a payment that must be made, or a payment that could have been received but is forgone. In practice, however, it is recognized that such bargaining may be inhibited by "transaction costs", especially when there are many pollutees who must bear the costs of organizing themselves to negotiate with one or a few polluters. There may not be sufficient incentives for an individual pollutee to join the negotiation, rather than be a "free-rider" and leave it to the others. Furthermore, the pollutees are often at a severe disadvantage with regard to information about the quantity and nature of the pollution and its costs (see Mishan 1971a; Polinsky 1978; Sproule-Jones and Richards 1984). Nevertheless, EIA and other emerging institutions for environmental management can very usefully be thought of as negotiation or bargaining processes (Dorcey 1984). The urgent practical question for such institutions, and for environmental management generally, is how to overcome the problems inhibiting the initiation or successful resolution of these processes (Sproule-Jones and Richards 1984; Dorcey 1986).

Growth, Development and 'Sustainable Development"

At the beginning of this chapter, it was stated that imparting an understanding of the current status of the environment in economics is problematical because economic theory is ambiguous about what constitutes "the economy". Clearly, all of Economy 1, Economy 2 and Economy 3 are important to the material conditions of our well-being. Yet, the core of existing economic theory deals exclusively with Economy 1. In economic theory, Economy 2 and Economy 3 appear as shadows or boundary conditions on Economy 1. Indeed, in conventional cost-benefit analysis, Economy 2 and Economy 3 are represented (if at all) in terms of "shadow prices", which are given, exogenous parameters. Conventional economic theory does not provide a means for considering interactions including possible feedback among Economies 1, 2 and 3. Yet, it is precisely with these interactions that many new problems are emerging. Hence, there is an urgent need to develop more general models of these interactions.

The exclusive attention which economic theory gives to Economy 1 is illustrated by notions of the economic value of production or consumption, such as Gross National Product (GNP) or Gross Domestic Product (GDP).

GDP is the sum of the net value gained in all market transactions of products and services in Economy 1. It is a measure of the "size" of Economy 1. Yet GDP is often taken as a measure of the material conditions of well-being. This can be misleading for several reasons (the following based on Goodland and Ledec 1987; see also Liepert 1986):

1. GDP may not reflect the material conditions of well-being of the bulk of a region's population if income distribution is very uneven.

2. GDP does not include production in the household or community, which may be especially important for the poor; expansion of Economy 1 at the expense of household or community production could make them worse off.

3. Many products and services purchased in the market are intermediate products for further production in the household; a stove which lasts 10 years provides the same service as five stoves which last 2 years each, although it will likely account for much less than the five stoves in terms of GDP.

4. Economic activity devoted to defending from, or compensating for, negative externalities (e.g. medical costs necessitated by exposure to toxic chemicals) gets counted as **positive** in GDP, although it really represents something **negative** in terms of human well-being.

5. GDP measures only economic flows, without regard to how much of these flows result from the "liquidation" or loss of man-made or natural capital. Policy-makers can thus temporarily raise a region's GDP by squandering its resources.

Taking into account some of these considerations can give a very different picture of the progress made through economic development in recent years (Daly and Cobb 1989).

Even where the concept of GDP has lost some of its appeal, "economic growth" may still hold great significance as a policy goal, even though economic growth is only the growth of GDP. Furthermore, the notion of "economic development" has become virtually synonymous with economic growth, although it may be tempered with a requirement that the number of people in absolute poverty does not increase and that the distribution of income does not become more unequal (Arndt 1981; Barbier 1987). Recognizing that poverty is not only oppressive for the poor themselves, but that it can also lead to rapid environmental and resource degradation by the **poor** for the sake of survival, the World Commission on Environment and Development (WCED) (1987) has called for a revival of economic growth.

Recognizing also that some recent patterns of growth have often not helped to alleviate poverty, but in some cases aggravated it, and that growth in developed countries must reduce its material and energy demands if it is to be sustainable, the Commission has also called for changes in the **quality** of growth. The challenge is to define more precisely what these qualitative changes must be and how they can be realised. This will likely require a redressing of the recent trend, in vogue since the Commission's report, whereby the *study of poverty as* a cause of *environmental degradation has become more fashionable (and richly funded) than the study of wealth as the main human threat to the environment* (Martinez-Alier 1990).

While economics has gradually been incorporating resource and environmental concerns, recent doubts about the overall prospects for ever-expanding economic growth began with the "limits to growth" debates (Meadows *et al.* 1972; Daly 1973; Hirsh 1976; Hueting 1980). With prompting by new theoretical formulations such as thermodynamic theory (Georgescu-Roegen 1971, 1976, 1979, 1981), steady-state economics (Daly 1973) and evolutionary economics (Boulding 1981), a greater appreciation has grown of the limits imposed by finite non-renewable resources (especially fossil fuels) and by the finite residual-absorbing capacity of the environment. It has become evident that economic growth based on continually increasing throughput of materials and energy is no longer feasible for the world as a whole, and especially for the developed countries. There is nothing inherently self-limiting in the dynamics of growth of the market economy, however; any limits on the **scale** of economic activities and on populations must derive from social or ecological restraints (Daley and Cobb 1989).

Nevertheless, some hold out promise that new forms of economic development can still continue in developed countries, even with steady or declining resource and energy consumption, based on sustained growth of the "information economy". Indeed, knowledge is likely to become an increasingly important economic factor in promoting efficient use of resources and energy, in developing substitutes and in protecting and restoring the environment. Countries that take the lead in developing environmentally-sound practices and technologies could enjoy additional economic benefits as exporters of these technologies while late adopters could face reliance on imports.

The challenge now for developed and developing countries alike is to adopt strategies for "sustainable development" which best provide for *economic and social benefits available in the present, without jeopardizing the likely potential for similar benefits in the future* (Goodlandand Ledec 1987). To meet this challenge there is a recognition that economics will at least have to expand its scope of concern from Economy 1 to

Economies 2 and 3 and the interactions between these "three economies".

Although tentative steps are being taken in this direction, there are still insistent demands to be shown that environmental conservation "pays". In practice, these amount to demands that any claims of adverse effects must be shown to be adverse in terms of Economy 1 before these claims are considered warranted. Meeting these demands is very difficult beyond those cases where the paths of effects are very direct and obvious. This diff iculty also contributes to the limited efficacy of common law in dealing with environmental problems. Furthermore, preoccupation with such attempts misleadingly keeps the focus of attention of policy-makers and economists on Economy 1 when an expansion of concern to all three economies is urgently required.

Serious consideration should be given to whether it might not be a better use of economists' skills not so much to **show** that environmental conservation pays, but to devise efficient means to **make** environmental conservation and restoration pay, especially through the internalization of externalities, but also increasingly taking into account interactions among the three economies. Consider that it is not required that it be shown that private investments "pay" for society as a whole; there are merely attempts to adjust incentives through public policy so that private (and public) investments are made only where the social benefits exceed the social costs. Similarly, rather than requiring that each environmental conservation project or policy be shown to "pay", economics might be more useful in helping to devise overall, efficient incentive structures to achieve or maintain environmental quality objectives.

To meet the requirements of "sustainable development", we must also expand the horizon of our concern temporally to include externalities not only for the present generation but also for future generations. As discussed in the next chapter, new institutions are needed and are emerging to cope with this challenge. The more that *we* rely on governments to mitigate and compensate for present negative externalities, rather than requiring that they be internalized, the more we impose on future generations the double burden of resource and environmental degradation and growing government debt.

Recent reports on environment and development issues (WCED 1987; National Task Force on Environment and Economy 1987) have expressed the hope that this downward spiral can be reversed and that the environment and the economy can work together. The Ministers of Environment of the OECD countries recognized in 1979 that *in the long run environmental protection and economic development are not only compatible but interdependent and mutually reinforcing* (OECD press release quoted in Ahmad 1981). Economic theory indicates that there should be no contradiction between a perfectly functioning economy and environmental conservation. In fact, economic theory would suggest that they should be mutually enhancing **if all externalities are internalized.** If positive as well as negative externalities are internalized, there will be incentives not only to refrain from degrading the environment but also to restore and enhance it.

Accomplishing such internalization will place greater demands on improvement of our environmental and ecological knowledge than our economic knowledge. Pearce (1976a, 1976b, 1987b) argues that the correct degree of internalization depends on ecological dynamics, not just on the current ecological state, and would amount in practice to establishing ecological bounds on the economy. If the correct degree of internalization is misjudged, or is not fully achieved in practice, the results may be catastrophic in some cases. We must be cautious and prepared to learn rapidly from the results of what we do and change our behaviour accordingly. Ecological prudence and adaptive strategies (Holling 1978; Clark and Munn 1986; Archibald 1980; Dryzek 1987) are therefore required.

Other Potential Causes of Environmental Degradation

So far, we have focused on the related problems of externalities and over-exploitation of open access resources as the major economic causes for resource and environmental degradation. There are also other potential causes of resourceand environmental degradation in the ways that actual economies operate. These other sources of "market failure" or "institutional failure" identified in economic theory can often compound externalities and open access problems. Some of these other potential sources of resource and environmental degradation are introduced more explicitly here because they also need to be recognized in environmental policy. These brief discussions, and the references they cite, are very cursory, and by no means exhaustive.

Tax/subsidy and regulatory policies

Government policies, including taxes and subsidies may have adverse or beneficial effects on conservation. If tax policies do not make appropriate provisions for farmers

to deduct all of the costs that they incur for soil conservation in determining their taxable income, they will not have the appropriate incentive to invest in soil conservation. Similarly, just as tax policies may affect incentives for conservation, subsidies for farmers to let land lie fallow may expose soil to erosion or other deterioration. New ways of accounting for the costs of resource use and resource conservation are needed (Crerar 1986a).

There is an increasingly evident need for review of the environmental and resource impacts of government policies, including taxes, subsidies and regulations. Such impacts would include, for example, the impacts of tax policy on incentives for conservation of soil and other resources (Crerar 1986a; Bond et *al.* 1986; Repetto 1988b; see also Repetto 1988a with regard to forestry; Kosmo 1987 with regard to energy; and other publications of the World Resources Institute). Economic analysis would be an essential component of this kind of strategic environmental impact assessment. Similarly, programs to regulate and support the resource sectors should be assessed to determine their possible implications for environmental and resource degradation (Manning 1986).

Lumpy costs and economic hardship

Lumpy or discontinuous costs may inhibit private conservation measures (Ciriacy-Wantrup 1952). For example, economic hardship for farmers or other resource operators may lead them to disinvest in their operations, including neglecting costly conservation measures, in order to stave off bankruptcy. If the economic hardship is prolonged, this neglect can manifest itself in serious soil erosion or other deterioration (Collins and Headley 1983). In good economic times, operations may expand to marginal areas which may be especially prone to such deterioration when the economy turns bad. These problems may be exacerbated by misplaced incentives arising from tax or subsidy policies such as those referred to above (Crerar 1986a).

Lack of information

Economic theory generally assumes that producers and consumers each act individually in their own best interest with perfect information. However, many operators, especially small operators may lack the necessary information required to prevent or abate pollution or conserve resources. Even large operators may not have appropriate incentives to keep up to date on the latest technologies and techniques. The costs of sharing information and coordinating action to deal with large-scale environmental issues may be too great, and the results too uncertain, for such efforts to be organized in the private or voluntary sectors. History has shown many examples of pollution control policies where the most effective component was simply providing information and technologies for waste recovery, often including the recovery of valuable materials (Vogel 1986). Industrial associations can play an important role in disseminating information. At the same time, attention needs to be given to institutional barriers to practice of the "four Rs" of waste management: reduction, reuse, recycling and recovery (Adamson 1984; Barton 1979; Campbell and Glenn 1982; Huisingh et *al.* 1987; Sittig 1975). Adoption of such practices can provide some of the most dramatic examples of "environment-economy integration" because they not only help to reduce pollution, but also result in cost savings to industries themselves.

The EIA process can be conducted to offer special opportunities to address economic inefficiencies attributable to lack of information. For traditional EIA of projects, information is especially required about **alternative** technologies and ways of coordinating the immediate interests of a project and the long-term interests of those who will be affected by it. It makes no economic or environmental sense to evaluate a single project alternative isolated from the environmental, socio-economic and technological context in which it is to be implemented. Several alternatives should be evaluated for their relative advantages and disadvantages, each in terms of its overall contribution to environmental-economic development and sustainability. In order for this to happen, and for coordinated action on environmental issues generally, efficient means and incentives need to be developed for involving all those affected. If this involvement is by way of negotiating or bargaining, however, there may be substantial problems of asymmetry of information, as well as of lack of information, among the parties (Sproule-Jones and Richards 1984; Amy 1987).

Some economists also believe that lack of reliable information may be a problem at the macro level by preventing existing resource markets from providing the correct price signals to induce the appropriate level of conservation of private resource stocks (Smith 1979; Norgaard 1990). In response to this, some would advocate the production of more and better information about resource stocks, prospects for substitutes and likely future demand, while others suggest that some form of "indicative planning" is called for (Meade 1970). However,

the stronger case for planning probably rests on considerations of intergenerational equity (see Intergenera*tional equity).*

Lack of research and development (R&D)

Economic theory generally predicts that private investment in R&D will be below that which is socially optimal to the extent that copyright and patent arrangements fail to provide optimal incentives to discoverers or inventors. In the case of R&D in the environmental field, this shortfall in returns, and thus the incentive for investment, is especially severe. This is because the benefits of more environmentally sound technologies and practices to their immediate users are limited to the extent that externalities are not fully internalized (so that even users of technologies for controlling externalities do not benefit from this use, because, by definition of externality, these benefits fall on others). This results in a slow pace for the private development of new environmental technologies such as recycling processes and abatement equipment for pollution control. In the long run, therefore, there is a tendency for technology to evolve in a direction that ignores environmental concerns. We usually think of such innovations in terms of hard, engineering inventions. More broadly, however, they extend to adoptions of new techniques, and innovations in practices, institutional arrangements and norms (Coleman 1986).

Economic analysis may be able to indicate the means, or at least the value, of **making the interaction between EIA and R&D more productive.** EIA offers a context in which R&D can gain close contact to actual environmental problems and, if the economic incentives in the EIA process are adequate, R&D will respond to them. EIAs should become spurs to the development of new technologies and practices and not precedents which justify lack of innovation. As already suggested, there is great potential for bringing new technologies such as computers and biotechnology and new techniques such as aquaculture, silviculture and integrated pest management to bear on environmental and resource problems. The development of Canada's nascent environmental industries has great potential not only for addressing domestic environmental and resource problems but also for export and balance of trade with the rest of the world. At the same time new technologies and techniques may themselves need to be subject to a kind of environmental impact assessment or technology assessment to steer R&D in environmentally-sound, and away from environmentally-hazardous, directions (Kapp 1983).

Discount rate

A more controversial question in economic theory is the discount rate that should apply to environmental maintenance and conservation. Some economists argue that the appropriate discount rate is the market interest rate that private firms would face in borrowing for capital investment projects. Other economists argue on various grounds that the social discount rate should be closer to the generally lower interest rates at which governments may borrow. What economists have hitherto considered the "optimal rate" of conservation is very sensitive to the choice of discount rate, with lower discount rates generally suggesting the need for more conservation. However, this relationship does not always hold because lower discount rates may tend to favour projects with immediate resource costs and longer-term benefits.

Some authors have questioned whether application of high discount rates to environmental degradation and resource use might be a kind of "social trap" (Costanza 1987; Costanza and Daly 1987; Goodland and Ledec 1987). Although there may be reasons for adjusting discount rates somewhat in some cases, in general the discount rate is too blunt an instrument for trying to effect general changes in environmental and resource policies (Markandya and Pearce 1987, 1988). Long-term sustainability is better addressed by taking intergenerational equity explicitly into account.

Intergenerational equity

Apart from the preceding purely economic considerations with regard to environmental protection and conservation, many would argue on ethical grounds that conservation and investment of resource rents should be sufficient to assure equity among present and future generations. As already indicated, such "intergenerational equity" seems to be required for sustainable development. The implications of this for the trade-off between resource use and capital accumulation, taking into account resource-augmenting technical progress, are too extensive to discuss here. Roughly it may be said, however, that intergenerational equity would require that care be taken to ensure that the endowment of resources and capital (including knowledge) be such as not to allow (per capita) productive capacity to decrease from one generation to the next (Robson 1980; Becker 1982; Hartwick and Olewiler 1986).

On the basis of the kinds of production functions generally assumed in economic analysis (i.e. either Cobb-Douglas or CES functions), no input is strictly a limiting factor (in contrast to "production functions" in ecological systems). However, if it can be argued that there is some resource that is such a limiting factor for several generations, and that no substitutes could exist for this resource during this period, then intergenerational equity would require that present uses be considered equally with all the foreseeable demands and "extractive capabilities" of those future generations (Mishan 1977; Pearce 1977). Some economists suggest that cheap energy from fossil fuels may be such a limiting factor (Geogescu-Roegen 1976, 1979, 1981; Hall et *al.* 1986).

There is some individual incentive to conserve some private resources to the extent that individuals value making bequests to society or their progeny. Here again, however, there is an absence of social institutions through which people can exercise their preferences for conserving and making bequests of common property resources (Osberg 1985). Pure, natural water or wilderness or heritage properties may be resources of this kind.

There are already some legal protections for some of these resources such as ecological reserves and heritage properties. However, there may be other ways that intergenerational equity might be taken into account in EIA and environmental and resource policy generally. For example, it might be possible to appoint spokespersons to represent future generations as "stakeholders" in EIA processes.

Equity, whether intergenerational or intragenerational, also has implications for compensation policies in EIA. In this area, a broader kind of economic-ecological analysis may help to indicate not merely the value of losses or damages but the awards and other measures necessary to restore a damaged or disturbed economy-ecosystem to renewed productivity, viability and sustainability.

Regulatory capture

Dealing with all of these problems would be simplified if we could count on omniscient regulatory agencies which had as their only purpose to serve the "public interest". However, substantial evidence has been presented in the economics literature that legislatures and regulatory agencies are subject to capture by the interests that they are supposed to regulate (Stigler 1971; Ackerman and Hassler 1981; Maloney and McCormick 1982; Pashigian 1985). Capture may not be the result of venality. It can merely be a consequence of the need to maintain a "good working relationship" between regulator and regulatees. Regulatees may also be selective about providing important information on which the regulator's decisions depend.

Economic and institutional analysis should help to indicate how environmental and resource regulatory agencies can be prevented from being captured by particular interests. In the case of EIA, the most effective measures might be through encouraging the countervailing activities of public interest groups.

By addressing the various potential economic causes of environmental and resource degradation, it is thus possible to indicate key points in economic activity where economically-sophisticated environmental management policies could better influence the course of development toward environmentally-sound practices.

3. INSTITUTIONS FOR ENVIRONMENTAL SUSTAINABILITY

In the previous chapter, we considered several causes in the actual operation of the economy that can lead to degradation of the environment and insufficient regard to environmental values generally. Suggestions were also given of ways that some of these causes could be tackled directly. Such direct measures may be most appropriate where a prominent cause of environmental degradation is particularly damaging, well understood, common and continuous. Often, however, an economic activity may generate many different kinds of externalities and involve other causes of environmental degradation that are not all well understood. It is generally more practical to address such pervasive situations more indirectly, by having in place an institutional framework that can recognize unacceptable environmental harm, and trigger countervailing responses. Environmental assessment can be considered to be part of such an institutional framework but other approaches are emerging and required. Many of these approaches complement environmental assessment and the effectiveness of all of them could be strengthened if their interrelationships were better appreciated (Archibugi 1989).

Strengthening Private Remedies

In addition to the greater efforts being made by public authorities to enforce environmental standards, further changes could be made to make it easier for private parties to obtain legal remedies for environmental harm. As already noted, the scope of tort and negligence law is expanding and awards for damages and legal costs are increasing. More could be done to permit class action suits in Canada, and to allow non-profit environmental organizations to bring forward environmental cases.

Greater government accountability might be promoted in Canada if non-profit organizations were allowed to bring government departments and agencies to court to require that they abide by or enforce environmental law, as is a practice in the United States. Other suggestions for reform are offered by Schrecker (1984). The intention here is not to bring about a "privatization" of environmental law and regulation but merely to provide private recourse to prompt public agencies to action, or to supersede them when they fail.

These changes encourage the internalization of externalities through private action. They all have potential implications for EIA, because the possibilities of subsequent legal action affect the attention and care which will be given to different aspects of an EIA and the incentives to involve stakeholders early in the process.

Attention should also be directed to the economics of public law enforcement, both of general environmental law (Russell 1971; Russell *et al.* 1986) and of the commitments to environmental measures which proponents make in the course of EIA processes.

Environmental Bill of Rights

A logical extension and consolidation of environmental law reform would be an environmental bill of rights. While many people agree that the idea of an environmental bill of rights is attractive, there is less agreement on what it should contain.

From the perspective of EIA, the most important aspects would be the procedural, as well as substantive, rights such a bill would acknowledge among participants in the EIA process and in environmental policy generally. The standing of stakeholders in the EIA process does not yet have a legal basis. The principles of sustainable development suggest that questions of justice and economics should be related in addressing this question. The practical knowledge and participation of resource users, native people for example (see Nakshima 1989) is indispensable in determining what kinds of development within a region are sustainable.

As well as determining their standing, an environmental bill of rights may better define the substantive rights on the basis of which stakeholders in an EIA may negotiate or bargain.

Round Tables

The National Task Force on Environment and Economy (1987) has recommended the establishment of Round Tables in each jurisdiction in Canada. These would be *drawn from senior-decision makers in the groups in its jurisdiction which have significant interest and expertise in environmental and economic issues, including: government; industry, both large and small; environmental organizations; labour; academia; and aboriginal peoples.*

It is not yet clear what the scope and function of the Round Tables will be, but one function might be to review

or formulate development plans or new policies in their early stages, or even to sponsor explicit environmental planning. They may provide a forum for the kind of strategic planning for sustainable development suggested above (see Lack of Research *and Development,* page 9). Round Tables can also advise governments on ways to ensure that environmental costs are reflected in economic accounting, prices and incentives, promoting the implementation of 'full-cost pricing" (i.e. internalization of external costs). [1]

Irreversibilities and Safe Minimum Standards

The most serious environmental and resource problems are those where degradation and depletion become irreversible. There comes a point in the degradation or depletion of ecological resources where reversal of deterioration becomes no longer economical and beyond that where it is no longer even technically feasible. In some cases, going beyond such a critical zone leads to a permanent environmental loss. In other cases, it marks an interruption until natural recovery of the resource can take place. Thresholds of ecological instability may be far from the actual exhaustion of the resource. Table 1 shows some irreversible environmental changes, indicating whether they are permanent or are subject to natural recovery over a time period of the order of magnitude shown.

Recognizing such irreversibilities, most economists acknowledge the need for governments to set safe minimum standards and take measures to ensure that these standards are met. Safe minimum standards provide valuable guideposts for EIA and other kinds of environmental planning.

The simplest kind of safe minimum standards, both conceptually and practically, are those that can be made to apply everywhere. For example, persistent toxic chemical risks to human or environmental health can be and should be avoided entirely (a "zero-emissions" policy). It is impossible, however, to use fossil fuels without depleting them and it is very difficult to preserve all of the scenic or heritage resources we might like to save. Irreversible destruction of resources presents special evaluation problems which economists have attempted to resolve with the use of notions such as "option", "quasi-option", "existence" and "bequest" value (Arrow and Fisher 1974; Knetsch and Fisher 1974; Fisher and Krutilla 1974, 1985; Krutilla and Fisher 1975; Freeman 1984, 1985b, 1986; Walsh et *al.* 1984; Pearce 1987a).

Conservation and Restoration Strategies

Within a range of ecological resources there is, therefore, an inevitable social choice about which resources and how much of these resources should be conserved. Moreover, it is not only the total quantity, but also the geographic distribution, of resources that may be important. Consequently, there is a need for coordinated and consistent conservation strategies and plans at all geographic levels: local, regional, national, continental and global (Union Internationale pour la Conservation de la Nature et de ses Ressources 1980; Environment Council of Alberta 1986; Conservation Council of Ontario 1986; Pollard and McKechnie 1986; Canadian Society of Environmental Biologists 1987). Conservation strategies require governments to take the initiative and not merely respond to problems as they arise.

These strategies should also be coordinated with energy strategies that will see us through, and beyond, the impending depletion of fossil fuels or the reductions in the use of these fuels required to forestall global climate change. (On the need for conservation and development strategies at the community level, see, for example, Hall 1984, Ruskin 1986 and Laitner 1987).While there have been some attempts to develop conservation strategies at regional, national and global levels, they can hardly yet be called "coordinated and consistent". There appear to be no generally-recognized principles about what should be conserved and how much. Ecological principles (including recognition of the irreversibilities noted above) should be the basic criteria here, with economics helping to resolve remaining questions. Conservation strategies should be oriented toward maintaining or increasing the endowment of "natural capital", being the value of resources and the ecological productivity of the environment (Pearce, Markandya and Barbier 1989; Pearce and Turner 1990).

[1] The National Round Table on the Environment and the Economy were created to determine how best to harmonize economic development with environmental sustainability. Reporting directly to the Prime Minister, the National Round Table is an independent forum composed of influential individuals from government, business, science, strategic policy and the public interest sector. Unlike most other institutions which bring together individuals or businesses with common interests, this forum brings together traditionally competing interests. Rather than developing or delivering programs of its own, the NRTEE will seek to achieve its goals by forging new ideas and partnerships to address the important link between the environment and the economy, providing independent advice on sustainable development and helping to build a broad concensus on what must change.

Environmental change	Time for natural recovery
species extinction	permanent
loss of scenic/ heritage resources	permanent
loss of traditional knowledge	permanent
fossil fuel depletion	permanent
minerals depletion	permanent
climate change	permanent
compaction of aquifers	permanent
desettification	permanent? (tree planting?)
radioactive waste contamination	10^5-10^7 years (Pu239, U238 half-lives)
toxic chemical contamination	1O-l 0^6? years
soil loss	10^2-10^4 years at best
deforestation	10^2 years - permanent
ozone depletion	10^2 - ? (CFC life-time)
groundwater depletion	10 years - ?
acidification, nutrient loss	?
salination	?
habitat loss	depends on habitat

Table 1. Environmental irreversibilities

Clarity about these principles will be especially important when conservation appropriately moves beyond mere protection of resources to environmental restoration. For example, Fisheries and Oceans Canada's new Fish Habitat Management Policy calls for net **increases** in fish habitat in Canada. This obviously requires going beyond merely protecting existing habitat. Deciding how much to invest in creating new habitat, of what kinds and where requires joint ecological-economic analyses,

Integrated Resource Planning

The next step beyond conservation and restoration strategies is integrated resource planning. Here the concern is not merely to conserve a stock of resources but rather, how resources can be developed to yield the greatest net benefits on a sustainable basis, taking into account the ecological interdependence among resources. Integrated resource planning may include land use planning as well as planning for the use of other resources. Among these resources, common property resources are implicitly evaluated in the integrated resource planning process, where their value might be neglected otherwise.

There is growing interest in institutional arrangements for conserving and managing common property resources (Ruskin 1986). This is the focus for the work of the Common Property Resource Network (directed by Dr. C. F. Runge at the University of Minnesota), which now has more than 2,000 members worldwide. Experiments in methods for integrated resource planning are being conducted in Canada.

Environmental Impact Assessment

In economic terms, EIA is a means of anticipating and preventing externalities generated by a project before the project proceeds. EIA will be helped greatly by the development of conservation strategies and integrated resource plans. A great difficulty with EIA has been that environmental impacts and costs must always be evaluated "from scratch" and within the very limited timeframes and budgets available to EIAs.

As suggested previously, proposed projects can only be evaluated properly in relation to other potential projects. Ultimately the proper measure of the costs of a project is its so-called "opportunity costs" - the net benefits which it precludes realizing through alternative projects or implementations.

The concept of opportunity cost can be illustrated in an environmental context by the case of a proposed airport runway that would encroach on a wetland. The expected benefits of the runway might be estimated to greatly exceed the benefits that could be attributed to the wetland amenities and functions. Thereby, it is often mistakenly assumed that the "environmental values" represented by the wetland must always "lose out" against the "development values" represented by the runway. But even if, under some evaluation, the benefits

of the runway (over its construction and maintenance costs) appear to exceed all those benefits that can be attributed to the wetland, the economic question does not end there. This is because the real economic costs of the runway also include the opportunity costs of encroaching on the wetland **- all the potential benefits of the wetland that would have to be foregone.** Therefore, it is also necessary to ask whether the opportunity costs could be decreased and the net benefits increased, for example by putting the runway in another location where the loss of environmental values would not be as great.

The applicability of the concept of the opportunity costs of a proposed project has been demonstrated in several studies summarized by Krutilla and Fisher (1975). It has also been applied to projects such as pipelines by economists in Canada and the United States. Similarly, the resources and amenities on which a project draws should be evaluated in terms of their "marginal opportunity costs" (Pearce and Markandya 1989a) where "marginal" in this context means the rate of increase of costs for increases in the rate of usage.

With conservation strategies and integrated resource plans already in place, the opportunity costs associated with the environmental impacts of a proposed project undergoing an EIA will be much clearer. Resources will already have been "spoken for" in these pre-existing strategies and plans so that the environmental trade-offs that a new, proposed project demands will be evident.

Conservation strategies and integrated resource plans also provide a way to deal with a particularly vexing problem for EIA, namely cumulative impacts. Practice with strategies and plans will indicate what management measures are required to maintain a given level of environmental and resource productivity and, therefore, what intensification of such measures may be required, and at what cost, to compensate for additional impacts.

Technology Assessment

Technology assessment focuses on the environmental and social impacts of individual technologies and recurring practices while EIA looks at the impacts of whole projects. For example, one could conduct a technology assessment of all of the environmental impacts of a chemical through its complete life cycle from manufacture to storage, transport, use and environmental fate. Technology assessment should ensure that the environmental impacts of products throughout their life cycle are taken into account in product design and marketing and that preferably products are designed so that they can easily be recycled. Where the same technology may be used in many projects, a generic technology assessment of this technology can contribute to the speed and quality of the project EIAs.

Technology assessments are also relevant for addressing cumulative impacts. For example, one could conduct technology assessments of the environmental effects of a kind of agricultural equipment or practice for soil conservation, or of a kind of forestry equipment or practice for forest regeneration. Technology assessment can also encompass social effects such as implications for employment, skills and distribution of income.

Research and Development Strategies

Of total public funding for R&D in Canada of about $800 million per year from 1975 to 1980 (in constant 1975 U.S. dollars), only about 1.5 to 1.75 per cent (about $12-14 million) was in the category of "environmental protection" (OECD 1985d). However, this does not include an annual average research and development expenditures of about $175 million for "agriculture, forestry and fishing", about $80 million for "production and rational use of energy", $4 million for "urban and rural planning", and $44 million for "earth and atmosphere" for a total of roughly $300 million, of which an unknown amount may have been related to environmental conservation (OECD 1985d). In any case, addressing environmental concerns in the future will be greatly facilitated by ensuring that this and all current and future R&D work is sensitive to environmental and resource factors. Amir proposes measures of the interdisciplinarity of research programs (1985) and changes in the organisation of research (1987) that might help promote greater recognition of these factors.

Kapp (1983) suggests that [e]*very serious discussion of today's environmental crisis leads sooner or later to the question of the possibility of development and introduction of alternative technologies.. . .* The Science Council of Canada has also emphasized this theme (Science Council of Canada 1977; Schrecker 1983). Perhaps much of the present confrontation between industries and environmentalists could be more productively directed into this kind of "serious discussion". More generally, given the major, sustained effort that will be required, industries, environmentalists and governments should be negotiating plans and mutual commitments for how economic development will be redirected so as to be sustainable, and according to what timetable this will occur.

Framework for an Environmentally-Sustainable Economy

All of the approaches described above have been emerging as general answers to particular recurring environmental management problems over the past twenty years. Each approach attempts, in a different way, to deal with the disfunctionalities for the environment of modern economic systems. Nevertheless, the complementarities (and inconsistencies) of these approaches have not yet been fully recognized.

If economics, and other disciplines, are to provide a useful contribution to sustainable development, then it must be within some framework offered by these approaches. The provision of this framework cannot come solely from economics because the very need for the framework comes from the disfunctionalities of economies based on our current economics (that has focused exclusively on markets, with little attention to the broader institutional considerations bearing on the environment) (Bromley 1989). Nevertheless, a consistent framework is required for a new economics to make a contribution within it.

We should therefore be seeking to develop a consistent framework for an environmentally-sustainable economy encompassing the valuable features of each of the approaches described above. Such a framework should go even further in recognizing *sustainable redevelopment* (Regier and Baskerville 1986) of our environment and resources as explicit goals. In areas where ecological degradation is clearly apparent, this emphasis offers the greatest prospects for ensuring our well-being and that of future generations in an equitable way.

4. PREDICTIVE TOOLS

As discussed in previous chapters, the core of contemporary economic theory is concerned almost exclusively with the Market Economy. There is less understanding about the interactions of the Market Economy and the Political Economy and even less about the interactions of both of these in the Embedded Economy (see Figure 1). In general, the ways that the Embedded Economy can evolve - the coevolution of environment and economy - are little understood.

Nevertheless, analytical exercises such as EIA, whether applied to projects or policies, ultimately depend upon predictions or anticipation of possible consequences. Such predictions should not just consider one scenario or a limited number of outcomes but should explore the full range of consequences that are considered possible.

Insofar as these consequences can be both economic and environmental, they must currently be analyzed separately, the first with economic analyses, the second with biophysical or ecosystem models. Another approach is to specify ranges of acceptable environmental change and judge whether the project or policy is likely to exceed these. Similarly, one can begin by specifying environmental objectives and judge to what extent a project or policy is likely to help or hinder the achievement of these objectives.

Although there is currently a lack of fully developed tools for integrated environment-economy analysis, there are reasonable prospects for developing such tools within limited ranges of applications. This chapter discusses possibilities for the development of such tools from extensions of current tools of economic analysis. The current tools may already be called upon in EIA, especially with regard to any socio-economic impact components, but their usefulness could increase if they could also begin to take into account environmental factors.

Interdependency Studies

Within economics, the exclusive concern devoted to production and distribution of commodities and services has drawn attention away from the *interdependencies* between economies and their environments. In terms of Figure 1 (page 4), interdependency studies are those that explore the linkages from elements of the Political Economy (Economy 2) through the environment back onto the Political Economy. Dorcey (1984) suggests four types of interdependency analysis, which would *generate progressively more information, but, at the same time, would generally be increasingly more difficult to undertake:*

> *1. Analyze chains of physical and biological consequences arising from residuals discharge and resource use practices, whether apparent, potential or merely possible, in specified geographical areas with* a view *to identifying those consequences that might play a role in economic activity...*
>
> *2. Analyze physical* and biological *effects* that affect *cash flows whether by altering prices of commodities and services or by influencing the disposition of tax revenues...*
>
> *3. Analyze feed-back loops that start with a residual discharge or a resource use practice and subsequently have an effect on a resource or on human health that has economic ramifications.. .*
>
> *4. Analyze the vulnerability and resilience of the economic and ecological systems to increasing discharges of residuals and changes in resource use practices.. .*

These types of analysis could contribute in varying degrees to the processes of environmental and resource negotiation and could be pursued to the extent that the stakeholders recognise the net benefits of their contributions to negotiation (Dorcey 1986). Other methods relevant to the analysis of environment-economy linkages have also been reviewed in a report for the Canadian Environmental Advisory Council (Knowles 1986); some of these other methods are also discussed herein.

Economic-Ecological Models

Continuing progress is being made in the integration of economic and ecological models. The earliest of these were "bioeconomic" models of renewable resources, most notably fisheries, which take into account the counteracting effects of harvesting and natural regeneration of stocks. The theory of these models is reviewed by Wilen (1985) while its applications to fisheries is reviewed by Munro and Scott (1985). Possible modifications of these models with new behavioural and institutional assumptions are suggested by Charles (1988).

Some of the broader potential of economic-ecological models for environmental studies are suggested by Bernstein (1981). Braat and van Lierop (1986, 1987) have recently surveyed and reviewed a wide range of economic-ecological models and their applications for the International Institute for Applied Systems Analysis. Van der Ploeg *et al.* (1987) have distinguished five general approaches to economic-ecological modelling: "stretching" existing concepts and methods, bioeconomics, compartment models, the systems framework approach and general resource policy analysis. They found that each approach has problems in some regards.

Many of these models focus mainly on ecological dynamics, with less rigour in the economic analysis. Nevertheless the joint development of such models in a workshop setting has been found to be very useful for interdisciplinary collaboration among scientists and communication among stakeholders in environmental planning or impact assessment (Braat and van Lierop 1987). Models developed in workshops can be used to test various scenarios as in Adaptive Environmental Assessment and Management (Holling 1978, ESSA 1982; Jones and Greig 1985; Regier 1985), or may be used in operational gaming techniques or "policy exercises" (Clark and Munn 1986).

Isard (1972) provided one of the early demonstrations of the integration of economic and ecological analysis applied to the design and siting of a marina, taking into account economic benefits and costs including loss of ecological productivity in an estuary. The evaluation methods developed by Kahn and Kemp (1985) for an estuarine ecosystem mark an improvement in economic sophistication.

Methods of analysis which treat the environment and economy as different "layers" (sometimes also including other layers for energy or employment, for example) in one overall model have been offered by Nijkamp and Delft (1977), Nijkamp (1980), Nijkampand Spronk (1981), Lakshmanan and Nijkamp (1983), Hafkamp (1984) and Hafkamp and Nijkamp (1984a and 1984b).

Hufschmidt *et al.* (1983) and Carpenter and Dixon (1985) discuss a wide range of approaches for including environmental and ecological analyses in project planning within a cost-benefit analysis framework.

While not incorporating explicit economic valuation, de Groot (1986, 1987) discusses an approach to environmental impact assessment based on environmental "functions", which usefully supplements approaches based on "valued ecosystem components" (Beanlands and Duinker 1983).

Further research activity in this area is being encouraged by the recently-organized International Society for Ecological Economics (contact Dr. R. Costanza, Center for Environmental and Estuarine Studies, University of Maryland) with its new journal *Ecological Economics,* that began publication in 1988.

Input-Output and Materials Balance Models

Input-output analysis was originally developed to trace the flows of products between industries and sectors in the economy. Its leading modern developer also recognized its potential for assessing the environmental impacts of industry (Leontief 1970). If it is assumed that each unit of an inter-industry flow has associated with it a certain level of residuals, then it is possible to determine the changes in residuals that can be expected from changes in economic output or economic structure. A good review of some of the early environmental applications of input-output analysis is offered by Emmett (1975). See also Lonergan and Cocklin (1985).

Environmental input-output modelling has not advanced very far in the last decade. The reasons for this are not clear but they may have something to do with the insufficient attention that was given to integrating these early analyses into actual economic and environmental decision-making. The practical benefits of these analyses were thus not as clear to administrators as their substantial costs. From his review, Emmett (1975) concludes that:

> *an issue of major concern is the appropriateness of the input-output framework to handle ecological interrelations. The many nonlinearities and thresholds involved in ecological interactions suggest that some relationships cannot be adapted to the linear framework and must be considered outside of the model... [T]he comprehensiveness of input-output analysis and the insight it provides into economic-ecological interactions must be weighed against the restrictiveness of the model's basic assumptions. No final assessment can be made solely on theoretical grounds, however. The value of these models can only be established over time as analytical and predictive tools.*

Recently, however, this approach has been applied at the national level in Norway (Forsund 1985). Victor (1972)

discusses some of the difficulties of applying the approach in Canada and Great Britain but has demonstrated its applicability in numerous projects, particularly in Ontario (VHB Research and Consulting, Toronto).

A kind of extended input-output analysis including environmental compartments as well as industries was employed by Isard (1972) for his study cited above. Isard has also indicated how to apply the approach in a regional context, as have Johnson and Bennett (1979, 1981).

At about the same time as Leontief was proposing input-output analysis for residuals assessment, Ayres and Kneese (1969) (see also Kneese, Ayres and d'Arge 1970) and then Kneese and Bower (1979) were developing a similar "materials balance" approach, based explicitly on the conservation of mass of materials as they flow through the economic process. This approach has also been applied at the regional level (James 1985), and can easily be used in conjunction with natural systems models (Basta and Bower 1982).

Whitney (1985) discusses the possible application of these approaches to EIA in Canada.

Econometric and Socio-Economic Simulation Models

Econometric models allow investigation of the implications of savings and investment in various sectors of the economy for output, employment, incomes and other aggregate economic variables. They thus allow testing of the consequences of following various economic policies. There have been many such models developed in Canada and elsewhere. Here we only consider some recent efforts to use such models to examine the implications of environmental policies.

Rather than the usual approach of using such models to develop strategies to maximise economic growth, Hueting (1987) reports on the results of using econometric models of the Netherlands to simulate the outcomes of *an economic scenario that gives top priority to saving the environment.* It was found that while rigorous environmental and energy conservation measures restrained growth in material output, they could generate employment and a more equitable income distribution.

Informetrica Limited has recently used its large, disaggregated econometric model of the Canadian economy to examine the economic (GDP) implications of more stringent environmental policies (Sonnen 1989). One of the cases considers possible productivity benefits for agriculture and forestry.

A tool for socio-economic simulation and scenario testing has been developed in Canada by the Structural Analysis Division of Statistics Canada in the form of the Socio-Economic Resource Framework (SERF). SERF is based on a set of accounting identities relating stocks and flows of people, capital, resources, etc. (McInnis 1984a, 1984b; Gault et *al.* 1987). Users of SERF can test the effects of policies on the dynamics of various "tensions" in the framework over twenty- to fifty-year time horizons, between people and employment, for example, or people and housing stock. Various feasibility studies have been done to incorporate environmental factors into SERF, including a National Residuals Simulation System (Bunnell *et al.* 1986). Geographical structure has also been incorporated into SERF to investigate scenarios at regional and watershed levels. In principle, SERF could offer a more flexible tool for investigating scenarios of the kind tested in the Dutch econometric model.

The basic socio-economic modelling approach of SERF is now being applied more generally by its developers (ROBBERT Associates, Ottawa). Researchers at the University of Waterloo, led by John Robinson, George Francis and Sally Lerner, are working with the SERF model and its developers to explore sustainable development scenarios for Canada over the next fifty years.

Pinfold (1987) considers the utility of other Canadian, large-scale, economic models for socio-economic impact assessment.

5. EVALUATIVE TOOLS

In economic analysis, it is sometimes difficult to distinguish methods oriented toward prediction from those which are intended more explicitly for evaluation. Most of the tools discussed in the previous chapter are primarily devoted to prediction. This chapter considers methods, based theoretically in welfare economics, which are more explicitly devoted to evaluation of changes in economic welfare from the current situation. These methods are considered here under the headings of "benefits and damage estimation", which is usually applied to overall policies or outcomes, and "cost-benefit analysis" (sometimes called benefit-cost analysis), which is usually applied to individual projects or programs.

Benefits and Damage Estimation

Several organizations, especially the Environmental Protection Agency and Resources for the Future in the United States, have engaged in major efforts over recent years to estimate in monetary terms national and regional **benefits** of environmental policies, especially pollution control strategies. Methods for benefits assessment, which generally rely on partial economic equilibrium concepts, are offered by Dewees (1980), Feenberg and Mills (1980), Freeman (1979, 1985a), Hershaft (1978), Johannson (1987), Kneese (1984), Maler (1971), McMillan (1975, 1980), OECD (1978, 1985c), Pearce and Markandya (1989b), Roberts and Sievering (1977), and Schulze et *al.* (1985). Kneese (1984) lists 18 extensive benefits assessment reports to the Environmental Protection Agency and almost 200 other publications related to the theory and practice of benefits assessment. The OECD also has a new report on benefits assessment (Pearce and Markandya 1989b). Some studies (OECD 1985c; Ostro 1980; Peskin et *al.* 1981; *Rose* 1983; Ehrlich et *al.* 1985) are concerned with macroeconomic variables such as growth and inflation, as well as overall benefits.

Various approaches have been applied to economic estimation of environmental **damages,** especially direct damages from pollution, to complement methods of benefit estimation. Theoretical considerations of damage estimation are addressed by Gregory and McDaniels (1987), Knetsch (1984), Maler and Wyzga (1976) and Pearce (1978). Applied studies have estimated economic damages from oil spills (Grigalunas et *al.* 1986; Federal Register 1987), from land-based pollution on coastal ecosystems (Kahn and Kemp 1985; Kahn 1987), and from acid deposition on the Canadian aquatic sector (Forster 1985), on forests (Crocker and Forster 1986), and, in preliminary terms, on agriculture (Forster 1987a).

Economists have used various methods to estimate epidemiological effects of air and water pollution, beginning with the work of Lave and Seskin (1971). These studies do not always attempt to quantify the costs of mortality and morbidity in monetary terms, although costs of remedial care are often included. A recent review of the U.S. Environmental Protection Agency's use of partially quantified cost-benefit analysis in regulatory development as part of its process of "regulatory impact analysis" found that such analysis was useful for guiding regulatory development, suggesting new alternatives, eliminating alternatives, adjusting alternatives and supporting decisions (U.S. Environmental Protection Agency 1987).

Cost-Benefit Analysis (CBA)

Cost-benefit analysis (CBA) is a method developed over the last fifty years for evaluating the relative overall socio-economic consequences of projects. It may also be extended to evaluate programs or policies. For simplicity, however, the discussion here refers to "projects", although most of what is said can be generalized to the applications of CBA to programs and policies. This domain of application makes CBA especially relevant to environmental assessment and any discussion of economics and environmental assessment must comes to terms with the potential application of CBA to environmental assessment.

CBA manifests both the strengths and the limitations of an economic perspective on the environment. It is therefore especially important to determine where CBA can help to clarify, and where it can obscure, the important considerations in decisions with environmental dimensions.

The method of CBA consists in predicting as far as possible all of the consequences of alternative projects and evaluating these consequences in economic (monetary) terms as benefits and costs.

Then, the best alternative in economic terms is that which yields the greatest net benefits (total benefits net of total costs). There are numerous general references on CBA, including texts (e.g. Pearce 1983) and official guides (e.g. Canada Treasury Board 1976).

The fundamental compelling argument in favour of CBA is that, within an instrumental, means-ends rationality, it constitutes the only rational way to proceed. In these terms, we appear to be confronted by a choice between "CBA or chaos" (Schrecker 1984).

There are two kinds of challenges that can be raised concerning the application of CBA, especially in situations involving the environment:

- Challenges of the first kind relate to practical difficulties and controversies in the technical application of CBA, usually about predicting and evaluating some kinds of consequences (especiallyenvironmental consequences). The ultimate recourse in response to these challenges is that no matter how serious these practical difficulties, if CBA is the only rational way to proceed, all we can do is work on overcoming them as best we can. If there are difficulties in **prediction,** these can be dealt with by better biophysical models and methods such as those discussed in the previous chapter. We will give more attention to problems of **evaluation** in CBA in this section.

- Challenges of the second kind, which we will consider in the next section, relate to the concept of rationality implicit in its procedural assumptions. As a procedure, CBA assumes that social choices can best be articulated and analyzed from the perspective of the presumed objectivity of a detached observer applying the CBA methodology. In other words, the rationality of CBA is a kind of autonomous rationality which stands separated from and above the social context to which it is applied. If there is another, or broader, kind of **social rationality,** then other, or augmented, procedures might be justified as being more rational.

Even within its own terms of prediction and evaluation, however, the actual practice of CBA in cases involving the environment can be challenged on several grounds:

1. CBA is based on the same "accounting system" as has been criticized earlier. Attempts can be made to incorporate "shadow prices" for goods without market values, but in practice, analysts have wide discretion about whether to include such goods, and if so, in identifying which goods to evaluate, and how to evaluate them. While economists may favour narrowing this range of discretion, and making CBA more standardized, there is no apparent trend in this direction.

2. CBA gives primacy to a notion of "efficiency" which many people would consider should be one of the lesser important social goals in a broader "social welfare function" for public policy (Bromley 1989). For example, CBA usually does not consider the distribution of cost and benefits among members of society, although many people consider equitable distribution an important goal (Nash and Pearce 1975). While methods have been proposed and used for incorporating equity considerations into CBA (Pearce 1983), they are not in widespread use today.

3. Furthermore, CBA is usually based on simple "static efficiency", where it is assumed that technologies do not change. It does not usually take into account "dynamic efficiency", where new technologies are encouraged or mandated and emerge. For discussion of the effects of environmental regulation on technological innovation, see U.S. National Science Foundation (1983).

4. CBA and risk assessment do not deal well with uncertainty, especially in cases where there is not a statistical record of events on the basis of which objective probabilities can be determined. This is often the case with new technologies with associated low, but unknown, probabilities of events causing heavy damage. One example of this is nuclear power plants. In such cases, assessment must generally fall back on the use of subjective probabilities. Any disagreements over subjective probability assignments are difficult to resolve.

5. CBA does not deal well with irreversibilities. Economists have attempted to develop and apply the concepts of option, quasi-option, existence and bequest values but it is questionable whether relevant values are actually revealed by these concepts, especially when many of the issues involved are also tied up with intergenerational equity.

6. CBA does not usually take into account intergenerational equity. Attempts to do so via discount rates have not been satisfactory. Conventional CBA may take into account the "psychic benefit" to the present generation of its bequest to future generations but not the benefits of that bequest to future generations themselves.

7. CBA does not deal well with the valuation of mortality and morbidity. Many people reject the idea that human life can be valued in monetary terms. Many would reject an offer of any amount of money in return for their lives or for imposing a risk on the life of anyone without their full consent. The proposed CBA procedures for the valuation of morbidity and mortality have yielded widely differing results.

8. More generally, CBA does not take into account the "down-valuation" (Kelman 1981) that occurs when attempts are made to place monetary values on "priceless" things, such as human life, important cultural artifacts or natural sites. This may be a consequence of the thesis elaborated in the next section *(CBA and Social Rationality)* that these and other things are evaluated differently by the individual *qua* citizen and member of the community than by the individual *qua* self-seeking "consumer" of economic theory (Sagoff 1988). At any rate, CBA does not take into account the possibility that citizens may be right when they resist the notion that there can be "rights" to pollute available for a price and instead attach a moral stigma to pollution. Although this moral stigma may be uncomfortable for polluters, it may help to rally and focus social concern about pollution, and provide a stronger incentive for the elimination of pollution in the longer term.

9. As commonly practised, CBA does not take into account the likelihood of future increases in the values of resources and amenities relative to manufactured (or "secondary") products. These relative increases can occur because of technical advance, making products relatively cheaper than resources and amenities, or because of cumulative losses of supply of resources and amenities, or because of increases in demand for them. Some economists have addressed these problems but their analyses are not widely applied in current CBA practice (see Krutilla 1967; Krutilla and Fisher 1975; Howe 1979).

Many economists believe these technical problems may have theoretical solutions and believe that CBA can be reformed into a useful tool for environmental planning. Many are working to overcome some of these deficiencies (Dorfman 1985). Progress in this regard is evident in works such as Knetsch and Freeman (1979), Hufschmidt et *al.* (1983) and James and Boer (1987). Nevertheless, a solution to a particular problem may only be applied in one or a few "demonstration" analyses, and not find its way into everyday CBA practice, perhaps because the budgets that administrators allocate to CBA do not usually allow more sophisticated analysis or extensive review.

In spite of any remaining technical problems, many economists believe that CBA is still a useful tool, even in situations with environmental dimensions. Indeed, some economists justifiably argue that the greatest risk to the environment comes from the failure to apply, or the misapplication of CBA. If CBA were applied to large projects (such as waterway and irrigation schemes) and policies (such as subsidies for land reclamation), which have substantial environmental implications, many might fail the test, even without considering all of the environmental costs. Krutilla and Fisher (1975) cite several such cases (see also publications of the World Resources Institute).

Howe (1979) also refers to cases of misapplication of CBA because of *political interference with the* **methods of technical analysis** (emphasis in original) where, for example, the wish to promote certain kinds of projects led the U.S. Congress *to legislate incorrect methods of water transportation benefit measurement* and *to dictate the use of inappropriate discount rates for many federal water projects.*

Where it is acknowledged that there are multiple project or policy criteria that are difficult to trade off in advance, some form of multi-objective analysis (Nijkamp and van Delft 1977; Nijkamp and Spronk 1981; Nijkamp 1989) may be more revealing than CBA. Multi-objective analysis is gaining greater application in many countries, especially in environmental matters. Multi-objective analysis allows economic and environmental factors to be considered separately in the analysis. These factors are then weighed explicitly by policy-makers at the end of the process.

By specifying multiple objectives, it becomes easier to separate "technical" issues from evaluative issues (e.g. the trade-off between equity and efficiency). This is in contrast to CBA which tends to obscure such distinctions in the effort to produce a single measure (net benefit) of project worth. Insofar as one accepts that evaluation of the effectiveness of a project or policy in attaining a given objective can be reduced to a technical problem, such evaluations can be assigned to technical personnel. Then there is greater justification to plead against "political interference" as does Howe (1979):

> *Clearly, technical personnel must be allowed to use the best scientific methods in providing multiobjec-*

tive evaluations of alternative policies or projects. On the other hand, technical agencies... must be required to provide unbiased analyses of the impacts of a policy project on all national objectives. Agencies often become self-serving by catering to special interest groups and presenting heavily biased economic, environmental and social analyses to the decision-makers. Then benefit-cost analyses and environmental impact statements become ways of obfuscating the facts and keeping the project implications hidden. Unless agencies are allowed and required to use the most appropriate scientific methods and politicians are willing to make decisions on the basis of unbiased, publically available data, the applications of benefit-cost analysis, social impact analysis, and environmental impact statements will be a sham.

CBA and Social Rationality

The foregoing discussion opens the way for a more general inquiry into procedural considerations given the social and administrative contexts of economic analysis.

As mentioned in the previous section, CBA assumes that it is possible, and indeed preferable, to evaluate social choices from the perspective of a detached observer. The modes of economic analysis discussed in the previous chapter also assume the perspective of a detached observer, but this does not immediately raise the same problems, insofar as they are descriptive and predictive, rather than evaluative, as is CBA.

This detached stance may mislead CBA where there is the problem of lack of information (information being costly to acquire). Like economic theory, most applications of CBA generally assume perfect information on the part of the analyst and economic actors. Where there is a lack of information, a much more participative procedure may be more efficient (Maxwell and Randall 1989). Such participation would allow economic analysts, scientists and economic actors to share information. This, in turn, could not only improve the analysis, but also directly lead to more informed and rational behaviour on the part of economic actors themselves. As remarked by Costanza (1990), [t]*he public is most likely far from being fully informed about the ecosystem's true contribution to their own well-being, and they may therefore be unable to directly value the ecosystem's services.* Scientists have an important role in informing the public in this regard. It is only on the basis of such informed public values that economists can draw inferences which they can claim have any kind of public mandate.

Nevertheless, the problem here may be much broader than a lack of information. Economic actors may also have conflicting and confused values. Like economic theory, CBA gives primacy to "consumer sovereignty", and unquestioningly accepts the values which economic actors express through their choices in the marketplace. Such values may be strongly influenced by culture, advertising and mass marketing, and may conflict with the values of the actor as citizen and steward of the environment and "common property" resources (Sagoff 1989).

Sagoff (1981) distinguishes between 'self-regarding" or "self-interested" values which can be expressed in market behaviour and "group-regarding" or "community-regarding" values, which usually are expressed through the political process. CBA and economic theory are in the tradition of classical liberalism. As such, they reject any notion of "group-regarding" values, drawing from the historical experience that claims on behalf of such values were often a mask for private interests and oppression. But this historical experience does not exclude the logical possibility that there may authentically be "group-regarding" values and that the satisfaction of these values contributes to an aspect of human well-being, just as the satisfaction of "self-regarding" values contributes to another aspect. Although the additional "group-regarding" benefits of some goods (e.g. education) are sometimes recognized in CBA through the concept of "merit goods", environmental goods have rarely, if ever, been accorded such recognition.

From the environmentalists' perspective, CBA may appear unsatisfactory because, by taking values as given, it allows little scope for environmental education in the decision-making process. Environmentalists have long known that the task of environmental education is as much about a change in values as about imparting information and for this they must compete with the ubiquitous promoters of conspicuous consumption. Furthermore, CBA ignores the possibility that values themselves may be irrational, both in the sense that they conflict and in the sense that they imply production and consumption patterns that are not ecologically sustainable.

Recognizing that values are socially and culturally bestowed, procedures for social decision-making should include modes of deliberation for resolving these conflicts between people's "self-regarding" and "community-

regarding" values. Of the kinds of procedures which have been discussed here, the most promising might be broadly-based participation in the development and application of conservation strategies. Public participation is necessary to ensure that there are public constituencies to implement these strategies. Public support generally is also needed to hold governments and their agencies to account for their part in implementation.

Conservation strategies would create a shift in economic emphasis toward rights to nondestructive and sustainable resource uses and away from rights to destructive and non-sustainable resource uses, with the balance progressively moving in favour of the former. As institutional changes, these would be classed as "reallocations of economic opportunity" (Bromley 1989) which maintain economic efficiency while better realizing environmental values.

Economic theory suggests two possible measures for the value of a right:

- **willingness to pay,** being the maximum amount of money people would be willing to pay to secure the right, and
- **compensation demanded,** being the minimum amount of money they would demand in return for giving up the right.

Economic analysis has generally assumed that these two measures are equivalent so that the initial allocation of rights has been considered inconsequential as long as the rights can be freely traded. In particular, CBA has usually adopted "willingness to pay" in practice.

In spite of this, there is considerable empirical evidence that compensation demanded may be several times greater than willingness to pay in common situations, even in the absence of income effects (Knetsch 1984; Knetsch and Sinden 1984). This, on top of the usual argument about transaction costs (Coase 1960), would suggest that the initial assignment of rights does matter. In particular, it does matter whether we initially assign rights to nondestructive and sustainable resource uses or to destructive and nonsustainable resource uses. To the question "Who should have the initial rights?", Krutilla and Fisher (1975) respond somewhat cautiously: *The answer is not obvious, though a better case can perhaps be made for assigning priority to the nondestructive use.*

There may also be other bases for the initial assignment of rights:

- **prior use,** especially in the case of indigenous peoples;
- **subsistence use,** versus commercial use; or
- **equitable use.**

Consideration should also be given to "soft" rights and responsibilities consistent with community norms, as well as to the "hard" rights conferred by legal institutions (Regier and Baskerville 1986). Some rights may even be deemed nontransferable and inalienable.

These considerations cannot be explored here. They are raised only to show that questions of allocation of rights are fundamental to environmental issues and yet cannot be unambiguously resolved by CBA.

The issue of initial allocation of rights also cannot be resolved by bargaining between affected parties. Promoters of environmental negotiations and mediation sometimes gloss over this question. Nevertheless, in negotiations too, outcomes will depend on the initial rights which are, explicitly or implicitly, accorded to the parties by mediators and sponsors of the negotiations (Amy 1987). If those speaking for environmental rights feel that these rights are not adequately recognized by the other parties, they may appeal for support outside of the negotiations to society at large. Although individuals may win or lose by reallocations of rights, the economic system can continue to operate on the basis of any allocation of rights, although it might be disrupted by uncertainties introduced by possibilities of unpredictable changes in rights. A major source of such uncertainties is the wide discretion, if not arbitrariness, of government departments and agencies.

The strong support of the public in Canada for environmental conservation as evidenced by public opinion polls would suggest potential support for strengthened environmental rights. However, these rights must be codified in an environmental bill of rights to be efficacious in legal, administrative and bargaining processes.

If the importance of both substantive and procedural rights is acknowledged, negotiating can make a substan-

tial contribution to environmental management. Indeed, much environmental management comes down in practice to negotiating in any case, whether it is negotiating between levels of government (in a federal system), between government and industry, or between all of these and other resource users (Dorcey 1986; Dorcey and Riek 1988). If governments represent public interests, and all parties become fully informed through the process, the results of negotiation cannot be anything but efficient (or "Pareto optimal") in an economic sense. These conditions are facilitated by adherence to "principled negotiating" (Dorcey 1984, 1986). Then, negotiating can also yield creative solutions that might not have been anticipated in advance.

Therefore, where negotiating is feasible as a means of resolving environmental and resource conflicts, it would be presumptuous and misguided to apply CBA to outguess and preempt the efficient outcome which negotiations would produce.

While thus limiting the application of CBA from those areas of environmental evaluation in which it is least competent, a negotiating approach might still draw on economic theory for help in identifying the values that need to be represented in the negotiating process. For example, it may be necessary for government agencies or appointed "stakeholders" to represent the values of non-users (option and existence values), or as previously suggested, the values of future generations.

Determining who the parties in a negotiation should be, and on the basis of which allocation of rights they should negotiate, is of course at the core of the problem.

The Prospects For Cost-Benefit Analysis

Mindful of the foregoing considerations, there may still be forms of modified CBA that can usefully be applied in environmental management and EIA in particular.

The compelling benefit of the CBA approach is that it demands a thoroughness and orderliness in taking account of the values at stake for everyone affected by a project or policy. The concept of opportunity cost, if properly understood and applied, could also do much to alleviate potential environmental conflicts.

There can always be disagreement over whether a CBA gives the appropriate magnitude or weight to a particular value. Nevertheless, CBA at least provides clear and general criteria for what values need to be considered, and what questions need to be asked about a proposed project or policy, its effects and its alternatives.

Without such criteria, relevant values can be left out, as for example, in the case of the mandate of the Environmental Assessment Panel for the Northumberland Strait Crossing Project. In its report (Barnes et *al.* 1990), the Panel noted that, although the issues raised were beyond its mandate,

> *citizens indicated that the following costs should have been considered part of the real costs of a fixed crossing: compensation to agriculture; compensation to [displaced ferry] workers; community development programs for those affected by the loss of [the ferry service]; road infrastructure; increased stress on provincial services; costs for reparation in the event of an environmental mishap (e.g. spill); cost of alternative service should the fixed crossing be out of service; long- and short-term compensation for losses to the fisheries.*

If the EIA had been conducted within the framework of CBA, these costs should not have been overlooked.

There can be some indeterminacy about what are to be counted as costs (or benefits) in CBA, where the allocation of rights is unclear. For example, in the foregoing case, the costs of compensation (if any) to displaced ferry workers will depend on the extent of legal and moral obligations that are recognized toward laid-off workers. Indeterminacy is obviously especially important where there are major disagreements over rights to land and other resources. It can also be important with regard to amenities and life-support functions, for which assignments of rights are often incomplete or unclear. The undetermined status of rights with regard to amenities and life-support functions contributes to the general problems of evaluating them.

Nevertheless, it can be instructive how far it is possible to proceed in an EIA that is conducted within the framework of a CBA without having to evaluate the amenity and life-support values that CBA is less reliable in quantifying. When such values are critical to the outcome of the assessment, then, as already indicated, it is appropriate to turn from CBA to negotiation and the search for public and political consensus. Resort to the latter methods is much more defensible when these values are at stake than using CBA methods of evaluation, which, taking into account the foregoing discussion, must be viewed with considerable scepticism in these cases.

When conducted in this way, assessments can help to produce general informationabout values, whether indicated **explicitly** by CBA techniques, or **implicitly** by weights which are apparently assigned to values in negotiation or public review. With this information about values it is possible to be more consistent in the relative weights given to factors in subsequent EIAs and more efficient in realizing these values in EIAs and environmenvironmental management generally. This is true not only for environmental values, but also for broad socioeconomic values. For example, many projects are undertaken in part because of their expected contributions to job-creation, although there is usually little consideration given whether the values that are thereby implicitly assigned to jobs are consistent across projects, programs and policies. In the absence of such consistency, there is little assurance that jobs are being created efficiently in terms of their economic (and environmental) costs.

Recognising that currently-held values may still not adequately take into account the contribution of the ecosystem (especially life-support functions) to well-being (Costanza 1990), it may be necessary to impose other constraints on cost-benefit evaluations and negotiations, such as a requirement of no net loss of "natural capital" (Pearce, Markandya and Barbier 1989; Pearce and Turner 1990; Costanza 1990).

This is one of the more theoretically astute suggestions now emerging for modification of CBA into a kind of **sustainable development assessment.** Much depends on what **accounting systems** can be developed for "natural capital." In practice, the development of such systems may coincide with the formulation of comprehensive ecosystem conservation strategies. Then, "no net loss of natural capital" could be made a minimum requirement of conservation strategies. Any CBA or EIA conducted with reference to a comprehensive conservation strategy, as advocated here, should then also be consistent with this principle.

6. CONCLUSIONS AND RECOMMENDATIONS

Consistent with the focus of this paper, the following conclusions and recommendations are offered for discussion specifically with regard to EIA. As previously, these statements with regard to projects can also be generalized to programs and policies.

1. **The economic and environmental assessment of a project can only be conducted properly by comparison of that project with other possible projects in terms of the economic and environmental resources that they require and their overall contribution to an environmentally-sustainable regional economy.** In economic terms, the true measure of the economic and environmental cost of a project is its "opportunity cost", that is, the value of the net benefitswhich could have been attained by allocation of the economic and environmental resources that are required by the project to the best alternative uses. In the case of environmental costs, these "best alternative uses" are often not immediately apparent. Rather, they must be revealed by comprehensive conservation strategies and integrated resource plans. In other words, the real environmental costs (or benefits) of projects should be measured in terms of what the projects subtract (or add) toward the fulfilment of conservation strategies and integrated resource plans. The need for these yardsticks is so fundamental that consideration should be given to the imposition of blanket moratoria on major projects in areas for which conservation strategies or integrated resource plans have not yet been developed.

2. **The preceding discussion provides ample reason for believing that cost-benefit analysis (CBA), at its current state of development and as it is commonly applied, systematically undervalues environmental costs and benefits.** Nevertheless, many projects, including large projects, of questionable economic and environmental sustainability, continue to be implemented even though it is doubtful that they would pass a CBA test. These projects only proceed at the cost of substantial government subsidies and misallocation. Therefore, CBA should be applied to projects to be implemented with government funding or support, in conjunction with EIA scoping and screening, at the initial screening stage. Any CBA should be open for public inspection and be subject to peer review by environmental economists outside of the organization that conducted the CBA. Progress should be encouraged in the development, application and standardization of CBA, including modifications on environmental grounds indicated **above.** Meanwhile, if a project with environmental impacts which are, on the whole, disruptive fails the CBA test at this stage, it should be rejected. If it passes the CBA test, it should still be subject to further EIA steps. In other words, passing the CBA test should be necessary, but not sufficient, for approval of such projects. Projects with an overall effect of enhancing environmental quality, such as sewage treatment plants and erosion prevention programs, but which may nevertheless fail the CBA test, should be subject to further review to see if their environmental benefits, that were not adequately evaluated in the CBA, outweigh their net pecuniary losses as determined by the CBA.

3. **Negotiating is a means of resolving environmental and resource conflicts that is compatible with economic principles and it should become the norm for dealing with such conflicts in EIA.** At the same time, further research, experimentation and practice are needed to determine which interests should be represented in negotiations, by whom, and what procedural and substantive rights they should be accorded in the process. Economics can help us with the question of representation, on the basis of our society's current value system. To the degree that a sustainable ethic or value system is given greater weight in public policy, every environmental "function" (de Groot 1986) should have a representative or spokesperson in environmental negotiations. Since this is probably not practical if the number of negotiators is to be kept manageable, attention will need to be given to how a manageable number of negotiating roles can be defined naturally to cover all of the environmental functions at stake. This in itself would be a powerfully educative process. Stakeholders would need to be made aware of how their interests are related to environmental functions in ways that they may not have considered.

4. **The information content of negotiating processes (or whatever other EIA procedures are employed) could be further enriched by making use of analytical tools such as economic-ecological models and input-output models.** The way in which any modelling exercise is conducted should be consistent throughout with its purpose in this context -- namely, to help in exploring and anticipating the indirect, as well as direct, project consequences that may ramify through economic and ecological pathways. Further research is needed on how such tools can be incorporated into negotiating processes and EIA procedures generally (Stokoe *et al.* 1988). In a recent

review of applications of economic-ecological models, Pearse and Walters (1987) conclude: [*t*]*he* real challenge *now is in learning how to embed the modelling process and its products more effectively in complex decision environments. This challenge will be best met by putting as much effort into the study of how models are received and used as has previously been placed in the study of how to build them.* Experience suggests that models are most useful in decision contexts when stakeholders and other users of these models participate in their development.

5. **Environmental negotiations should be conducted with a view to possible research and development (R&D) that might be undertaken to mitigate, or reduce, the environmental conflicts which the negotiations reveal.** Even if the results of such R&D could not be available soon enough to be applied in the project under review, they may still be useful for subsequent projects of a similar kind. The negotiations should also be conducted to develop a monitoring strategy for both environmental and economic changes that might be attributable to the project. Provision should also be made for a "post-audit" of the economic assessment, as well as the environmental assessment, of the project. The costs of negotiations, R&D, monitoring, mitigation, compensation and the post-audit should all be borne by the project proponent.

6. **The results of the negotiating process should augment the information on environmental costs and benefits originally considered in the CBA at the screening stage.** This new information could then be incorporated into the CBA to assist in final decisions on project approval by the project proponent and environmental reviewers.

7. The roles assigned to CBA, and other techniques, in the EIA process should be regarded as provisory and subject to rigorous review. The purpose of this review should be to detect where CBA produces misleading results, for some of the reasons cited above, both to correct these errors in the case at hand, and to improve CBA methodology for application in subsequent assessments. Support should also be given to research and development of techniques, such as multi-objective analysisand "sustainable development assessment," that might augment or replace CBA in some cases. The stages in the EIA process here proposed where errors in CBA can be detected are at the conclusion of negotiations, and in the course of the post-audit. To the extent that CBA and the conduct of negotiations improve, their results should converge, and both should correctly anticipate actual economic-ecological outcomes, as determined by the post-audit.

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CEARC SECRETARIAT MEMBERS

Patrice LeBlanc
Executive secretary
Telephone: (819) 997-2253

Ron Manitowabi
Researcher
Telephone: (819) 953-5244

Hélène Laberge-Jarvis
Receptionist/Typist
Telephone: (819) 953-2530

Robert Roy
Senior Researcher
Telephone: (819) 953-8591

Chantal Sirois
Administrative Assistant
Telephone: (819) 953-2395

POSTAL ADDRESS:

13th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
HULL, Quebec
K1A OH3

FACSIMILE NUMBER:

(819) 953-2534

ADVISERS TO THE SECRETARIAT

Robert Boulden
Chief, Environmental
Assessment Division
Conservation and Protection
Environment Canada
15th Floor, P.V.M.
350 St. Joseph Boulevard
HULL, Quebec
K1A OH3
Tel: (819) 953-l 690
Fax: (819) 953-4093

Barry Salder
Director
Institute of the North-
American West
1631 Barksdale Dr.
VICTORIA, B.C.
V8N 5A8
Tel: (604) 477-8752
Fax: (604) 477-8752

Robert H. Weir
Director, Environment Sector
Professional Services Branch
Canadian International Development
Agency
200 Promenade du Portage
HULL, Quebec
K1A 0G4
Tel: (819) 997-6731
Fax: (819) 997-4762

COUNCIL MEMBERS

Gordon Beanlands (Chairman)
School for Resource & Environmental Studies
1312 Robie Street
HALIFAX, Nova Scotia
B3H 3E2
Tel: (902) 494-3632
Fax: (902) 494-3728

Tom Beck
422 33rd Avenue N.W.
CALGARY, Alberta
T2C 0B4
Tel: (403) 277-1363
Fax: (403) 276-6032

Nancy Doubleday
141 Aylmer Avenue
OTTAWA, Ontario
K1S 2Y1
Tel: (613) 233-9596

W. Ray Effer
Ontario Hydro
700 University Ave., H10G1
TORONTO, Ontario
M5G 1X6
Tel: (416) 592-5202
Fax: (416) 978-0156

Michel Gariépy
Universite de Montreal
5620, avenue Darlington
MONTREAL, Quebec
H3C 3J7
Tel: (514) 343-6386
Fax: (514) 343-2 183

Susan Holtz
Stanbrae Road
Ferguson's Cove
Box 49, Site 15
RR5, ARMDALE, Nova Scotia
B3L 4J5
Tel: (902) 477-3690
Fax: (902) 477-5464

Esther Jacko
General Delivery
BIRCH ISLAND, Ontario
POP 1A0
Tel: (705) 285-4335
Fax: (705) 285-4532

David Kiell
Newfoundland & Labrador Hydro
P.O. Box 12400
ST. JOHN'S, Newfoundland
A1A 2X8
Tel: (709) 737-1494
Fax: (709) 737-1790

Henry Lickers
Mohawk Council of Akwesasne
P.O. Box 579
CORNWALL, Ontario
K6H 5T3
Tel: (613) 575-2377
Fax: (613) 575-2181

Luc Ouimet
Ville de Montreal
460, rue Saint-Gabriel
4e étage
MONTREAL, Quebec
H2Y 2Z9
Tel: (514) 872-7807
Fax: (514) 872-7849

Louise Roy
3855, avenue Northcliffe
MONTREAL, Quebec
H4A 3K9
Tel: (514) 481-2576
Fax: (514) 481-2576

Robert Walker
Saskatchewan Power Corporation
8th Floor, West Wing
2025 Victoria Avernue
REGINA, Saskatchewan
S4P 0S1
Tel: (306) 566-2877
Fax: (306) 566-3428