Accounting for Sustainability: Lessons from the Swamp

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The achievement of sustainable development will depend upon our ability to modify our activities and their impacts to be compatible with the long-term carrying capacity of the environment. But to change our impacts, we need to understand more completely both the environment and our effects on it. There is growing evidence that current development patterns, both globally and locally, are not sustainable. Our choice of options is strongly influenced by the messages we receive -- of what is good and bad, right and wrong, or beneficial or harmful to our success. The predominant standard by which these valuations are currently made is an economic one, which dominates our choice of indicators and measures (Milbrath 1989). Whether used at a national level, or to measure more local costs and benefits, a framework of economic accounting has become the central support mechanism for a majority of decision-makers. This paper examines the component functions of the environment and the benefits which derive from them. It questions the ability of current initiatives to broaden national accounting procedures to encompass many of the resource stocks and non-market benefits derived from the environment. It then identifies some of the challenges ahead if we are to successfully modify our national accounting procedures to encompass all that is important to the goal of sustainability.

Sustainable Development

The Brundtland Commission defined sustainable development as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (World Commission on Environment

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and Development 1987). While there has been considerable debate regarding the precise meaning of this term, most agree that it requires an integration of social, economic, and environmental values into our decision process, as well as lengthening the time frame and broadening the spatial parameters of our decision-making (Manning 1990). In a sense, we are trying to risk-reduce our collective future, through capturing the full range of those values and relationships which are important to future human and planetary wellbeing in an holistic decision-making process. Implementation of the concept of sustainable development, will therefore be predicated upon improvement to the decision process at all levels. This will require a revision of our approaches and to our instruments, and the generation of improved information (Repetto et al. 1989). But the path to holistic and environmentally sound decision-making lies through a complex swamp of biophysical functions and the rich systems of human and other demands which depend upon them. *We cannot effectively manage that which we do not understand.*

To understand more clearly the global interrelationships, it is sometimes useful to focus on the microcosm of a specific ecosystem. Much of the substantive content of this article is built upon empirical work done as part of five-year Canadian project aimed at improving wetland evaluation methods, addressing the problem of decisions affecting individual wetlands, and wetland environments as parts of larger regional or global ecological and economic systems (Manning et al. 1991; Bond et al. 1988; Bond et al. 1992). It also draws upon work on the valuation of environmental functions prepared for the book *The Challenge of Sustainability* (Kumar et al. 1993). Because wetlands are among the most complex of ecosystems, the approaches tested are more generally applicable to the assessment of the capabilities of a broad range of natural environments and to the values which society drives from them. The empirical work clearly demonstrates the practical challenge in identifying important environmental attributes and in measuring their sensitivity to alterations. Complicating the challenge is the question of scale and interrelationship. The service provided by a particular wetland system as migratory habitat is just one element in a much larger life support system which may span continents. The benefits which are obtained from an ecosystem may depend on synergies between discrete elements of that system which yield the unique capabilities of a site to provide aesthetic or production benefits. On site evaluators will not find it easy to document all of these relationships, much less value the benefits deriving from them, particularly if these benefits are widespread (carbon sink), or occur in other regions. The work on wetlands showed that the simple documentation of individual attributes and their related direct benefits was not sufficient to show many of the most important functions and benefits associated with the ecosystem under study. Clearly any evaluation must be done with reference to the place of the specific ecosystem within a larger regional or even continental/global framework.

Changing Decisions

The environment is managed by millions of individuals, each of whom makes decisions which affect the use of parts of the environment. Together, the cumulative effects of all these decisions determine the state of the global environment. Because most decisions are thought to be responsive to the "economic" messages received by the decision-maker, much attention has focused on the modification of these messages to better reflect the broader, longer term and equity-related values considered important to a sustainable future (for example, Daly and Cobb 1989; Costanza and Daly 1990; Crerar 1986). Given the pre-eminence of certain national accounting measures such as GNP, attention has been largely directed at the modification of these measures. This approach will likely prove unsatisfactory both because the influence of these broad measures on actual investment or development decisions by individuals is very indirect, and secondly because the current approaches to modification of this incomplete instrument are likely themselves to yield misleading messages.

Measuring Our Progress

The way we measure our progress at the national and regional scales is based fundamentally on the use of a limited number of measures of economic activity. Since the 1930s, national accounting, and in particular, national level indicators such as Gross National (or Domestic) Product, or balance of trade have been used as key measures of overall economic performance. As such they have had immense influence -- colouring the public (and private) perception of what benefits are, and when or how they occur. These measures, based on compilation of flows in all sectors of the economy, have attained a publicly perceived role as the basis of measuring whether the welfare of the nation has become better or worse. But it has become increasingly clear that these are incomplete indicators (for example, World Commission 1987; Ahmad et al. 1989; MacNeill 1990, among others). The standard means of compiling national accounts focuses on measuring the level of marketplace activity. National accounting procedures inherently contain no measure of many important dimensions of overall long-term welfare, including measures of resource stocks, or of values which are not directly represented in the marketplace (Friend 1988; Potvin 1989). Intrinsic (non-market) or existence value of the environment is not part of GNP, and few suggest that it ever can be. Further, the distribution of overall wealth, whether between social classes or between nations or regions is clearly a major contributing factor to welfare, particularly that of the individuals or regions -- yet this aspect is not normally measured. Efforts to incorporate adjustments into the accounts to compensate for skewed distribution of consumption remain problematic and are not part of the basic procedures but rather a form of after the fact adjustment to aid in comparisons of welfare of subsets of the population.

In essence, our national accounting is blind to whether increased production, consumption or trade occurs due to the drawdown of, or degradation of, resources, or due to a form of development which is built on natural resource strengths and is likely to be sustainable in the long term. It is also substantially blind with respect to social and intergenerational equity concerns, and is by design an anthropocentric measure, measuring levels of human activity in the marketplace. Used alone, our most common measure shows only a small part of the important things managers need to know, particularly if they wish to reduce the risk of environmentally or socially costly mistakes. Yet the signals which it gives to investors and regulators may lead them to actions antithetical to long-term sustainability of the ecosystem or of the enterprises it supports.

The Challenge of Choosing at a Regional Level

Applied at a local level, most currently used economic accounting tools also have significant limitations, which may result in misleading advice. At the local scale, project and program-level measures of net benefit have shown significant limitations of a nature similar to those in use at national scales (Manning 1987; Pearce et al. 1988). Most project-level decisions involve a form of benefit/cost calculation, frequently limited to measurement of the direct costs and the direct benefit flows to the proponent. In those cases where secondary benefits or external costs have been included, these have frequently been limited to specific benefits and disbenefits which are easily documented by the proponent(s) or opponent(s) and seldom involve a comprehensive, systematic approach to effects. This is not surprising, given the time and effort needed to address such system-wide concerns. Only for some of the largest projects (for example, major dams or diversions, or major World Bank funded infrastructure projects) have efforts been made to undertake system-wide social benefit/cost analysis, and to at least identify the broader and longer-term implications. Like the larger scale accounting procedures applied at the national level, local applications of project evaluation techniques have discovered that:

- it is much easier to compile and calculate benefits (and costs) in terms of the individual enterprise (or political unit) than in terms of society as a whole. Efforts to expand benefit/cost applications to social benefit/cost analysis have been complex, and, at best, incomplete and expensive;

- measurement of the dollar values of goods and services for which there is an active market is much easier than for those goods and services for which no market exists;

- many of the goods and services provided by the environment are not generally perceived to be goods and services by the general public. In fact, most are unaware of the existence of services like toxic buffering, function as a carbon sink, or groundwater recharge, and certainly have no perception of value associated with these services;

- the tools which exist to help establish values for these non-market goods and services do not work very well, both because too little is known of the actual biophysical relationships and too little is known about human behaviour related to the presence or absence of the goods and services which are supported by particular elements of ecosystems.

If the long term objective of sustainable development is to be achieved, there is much work to be done to enhance the tools at our disposal to support better decision-making at all scales. The overall goal is to enhance the means by which we measure the social costs and benefits of actions -- to improve the information received by those who make decisions regarding the future of nations, regions, and the ecosystems and species they contain.

Seeking Answers in the Swamp

How can we define what is important in the environment and assess changes in the elements which are critical to the long term sustainability of that which is of value? In 1986, a group of analysts, led by scientists from Environment Canada and Wildlife Habitat Canada, met to address a common problem: many of the functions of the environment they were employed to conserve could not be effectively demonstrated to be of value in terms which could be readily understood by decision-makers. The attention of this group was focused at the local and regional level, but also considered the challenge of evaluation of broader scale objectives which were supported in the aggregate by wetland resources, often at a regional or even continental scale. The research addressed the central concern of identifying the functions supported by particular environments and establishing their value to society in a way which could be used in the decision process. Wetlands were chosen as the pilot subject, both because they were perceived to be the most complex of environments and because they have been chronically undervalued or ignored by the planning process (Bardecki et al. 1988).

The ultimate target for the products of the research was local and regional planners and municipal and regional level decision-makers who are at the front lines of environmental decision making. To date these decision-makers lack the needed tools and methods to permit them to understand and internalize the full range of environmental values into their decisions. The findings of five years of research into valuation methods, and four case studies on wetlands in different ecological regions of Canada yield food for thought about how we identify and measure the value of environments at all scales, and help clarify some of the challenges ahead in trying to build tools which are sensitive to these factors (Manning et al. 1991; Bond et al. 1992).

Methods currently applied to the valuation of natural resources usually portray only a small part of the true environmental and economic value to society (Costanza and Farber 1986; de Groot 1986, 1987). Nevertheless, there is increasing recognition of the value of wetlands functions (for example, water storage, sediment retention, nutrient recycling, habitat, biomass energy) to society for wildlife and nature conservation, active and passive recreation, commercial plant and animal production, mineral extraction and risk reduction, among others.

Common Property Functions

Many of the functions of the environment are common property functions, even though rights to certain locations or functions may be privately held and managed. Part of the problem for evaluators is that they are having to compare values for marketed aspects of the environment (access, the right to fill and farm, the right to drain) with common property attributes which may be ill-defined and whose current and potential users are frequently unknown (migratory bird habitat, carbon sink, biodiversity, contribution to landscape variety or cultural interest). Yet, in many cases, these common property functions, and the values they serve, are of considerable significance, and may be the source of significant benefits at a regional or larger scale. One of the case studies undertaken in the project -- a case study of a region of thousands of tiny sloughs and wetlands in the Canadian Prairies -- suggests that, while it has been possible to identify and quantify in dollar terms some of the direct benefits to residents from wetland uses such as recreation or trapping, the larger scale benefits to migratory waterfowl, to aquifer recharge, and to maintenance of ecosystem integrity may be the key source of values to society at a continental scale deriving from their continued existence (Young et al. 1990). Further, because the small wetlands in the region exist in thousands, the marginal value of any individual pothole is very difficult to demonstrate, yet taken together the pothole region is the breeding habitat for a major part of North-American waterfowl.

Approaches to Valuation

What approaches to evaluation can encompass the full range of values deriving

from the environment and clarify which of them are critical to a sustainable future, locally and globally? The initial phase of the wetlands project involved the identification of potential evaluation approaches. The workshops identified three types which appeared amenable to modification to encompass a broader range of functions contained in the wetland environment. (Manning and Cox 1986). The methods initially selected for field-level investigation included:

- a **multiple function approach**, identifying a broader range of societal goals and objectives for the use of wetland functions than those generally encompassed by the term "economic"; these could then be used in a screening process;
- a **social benefit/cost approach,** involving opportunity cost concepts to be applied to net changes in measurable wetland values and to the net benefits deriving from the proposed alternate use; and
- techniques to measure the **willingness-to-pay** for wetland benefits based on contingent evaluation methods; to be used to provide estimates of the value of benefits -- most likely to be used as inputs into a social benefit/cost evaluation.

The **multiple function approach** entailed screening a particular proposal for alteration or elimination of a wetland against a series of specific standards or benchmarks (Nijkamp 1980; Cocklin 1988, 1989; Smith and Theberge 1987). These standards were designed to reflect the range of societal goals and objectives associated with or served by the wetlands environment (Bond et al. 1988). This necessitated the identification of the social values served by the functioning of wetland areas, and, of these, which were likely to be affected by a specific development proposal.

The documentation of environmental functions was derived from work by de Groot (1986, 1988) and adapted with help from the author for field application to wetland ecosystems.

Four categories of functions were used:

1. **Regulation functions** (buffering or absorption) such as climate regulation, toxic absorption, stabilization of biosphere processes, water storage, or cleansing. These generate benefits to society such as flood control, contaminant reduction, clean water, storm damage reduction, health benefits, and erosion control.

2. **Life-support functions** (carrier, ecosystem health) such as nutrient cycling, food chain support, habitat, biomass storage, genetic and biological diversity. These benefit society through maintenance

of ecosystem integrity, and risk reduction.

3. **Social/Cultural functions** fall into three sub-groups:

- *science and information* such as specimens for research, zoos, botanical gardens, representative and unique ecosystems providing humans with greater understanding of nature, locations for nature study, research, and education (field trips);
- *aesthetic and recreational* including non-consumptive uses such as viewing, photography, birdwatching, hiking, swimming. The benefits provided include personal enjoyment and relaxation, benefits to tourist industry, and to the local economy;
- *cultural and psychological*. Uses may be part of traditions of communities, religious or cultural uses, future (option) opportunities. Benefits may include social cohesion, maintenance of culture, behest value to future generations, symbolic values.

4. **Production functions** in two categories:

- subsistence production including natural production of birds, fish, plants, (for example, berries, rushes, wild rice) food, fibre. Benefits include self reliance for communities, import substitution, maintenance of traditions;
- commercial production including production of foods, (for example, fish, crops) fibre, (for example, wood, straw) fertilizers (for example, peat). Benefits include jobs, income, contribution to GDP.

The existence of particular functions was first ascertained. The next step was to identify the social goals (if any) which existed relative to the provision of the function or of specific benefits deriving from it, and to identify the projected impact of the proposal on this the function or benefit. A set of criteria, both quantitative (for example, recognized water quality standards) and qualitative (for example, general objectives related to conservation of habitat diversity) were identified from existing legislated and stated governmental goals and objectives. Where no policy goals were in place, other points of reference were sought -- for example, scientifically supported estimates of

demand for the function, particularly where thresholds could be identified. In the field, this proved to be rather difficult and time-consuming, but certain advantages became evident; this approach both encourages the evaluator to consider the full range of objectives which may be associated with the functions derived from the wetland, and identifies to policy-makers specific gaps where policies, guidelines, standards, thresholds etc. are missing.

Projects failing to satisfy one or more of the existing standards could, in some cases, be eliminated in initial screening, particularly if there was a legislated limit (for example, habitat for endangered species) which acts as a legal cutoff. But for most environments, specific legislated limits may be missing. Most environments will, therefore, need to be evaluated in light of their impact on a much broader range of identified societal values. In this approach, *because several different criteria are used to evaluate alienations, the analyst and the decision-maker are faced with a visible accounting of the cost of any given action through the explicit identification of which social values may be jeopardized by a specific proposal.* There seems to be advantage in not quantifying or establishing a hidden weighting system which produces a yes/no response: the visible accounting may serve to better make decision-makers publicly accountable for the subjective decisions they make.

The basis of evaluating the **opportunity costs of development** is the derivation of monetary values for the range of benefits derived from a wetland. Therefore, the initial concern in applying the method is in ascertaining the presence of any given wetland function providing benefits within a social benefit/cost framework. In some cases simple inventory techniques and observation can confirm many components of a wetland's value (for example, through surveys of hunting use or biological inventories of endangered species). In other circumstances, such data have proven to be fugitive or may not be feasible to obtain for monetary, time or technical reasons. There are a variety of means by which to perform the economic analyses of wetland values, once they have been identified (Batie and Shabman 1982).

The **contingent evaluation method** for estimating willingness-to-pay is reasonably well established (Mitchell and Carson 1989). A more or less hypothetical (contingency) market is established for non-market goods or services. This normally involves reliance on the collection of data directly from individuals to assess personal estimates of their valuation (for example, of a wetland area or of particular products or services which they may obtain from it). In some circumstances this valuation can be used as an input to the estimation of opportunity costs within a social benefit/cost framework. In the field, it soon became clear that the three methodologies were not mutually exclusive approaches, but together could operate to broaden the understanding of the range of functions and of their links to the valued benefits which were dependent upon them (Bond et al. 1992). This integrated approach became the basis of the field studies.

The Wetlands are not Wastelands Project

The objectives of the "wetlands are not wastelands" project were:

1. adapt existing methods and/or establish new methods for better evaluating the full socio-economic and environmental values of wetlands to society;

2. undertake pilot studies to test the selected methods vis-à-vis alternate uses in order to demonstrate the specific values of selected Canadian wetlands; studies were completed in Greenock Swamp - a forested marsh in Ontario (Bardecki 1988); Minudie Marshlands, a coastal wetland in Nova Scotia (Stokoe et al. 1989); Cowichan Estuary, a tidal marsh in British Columbia (Ferguson et al. 1989); and the Prairie potholes region in Saskatchewan (Young et al. 1990);

3. produce a Reference Guide to be utilized by resource planners and decision-makers and others as a set of desired screening procedures and methods for the evaluation of wetland areas in relation to proposed changes (Bond et al. 1992); and,

4. ensure the initiation of an effective on-going consultative process with a wide spectrum of involved groups regarding methods for the evaluation of natural resources, with the ultimate objective of improving the application of evaluation procedures to resource management and planning decisions in all renewable resource sectors in Canada.

The case studies were completed in 1990, and a reference guide for the use of decision-makers addressing decisions involving wetlands was published as a resource book (Bond et al. 1992). The testing of these approaches in the field has yielded results which suggest that the valuing of current and potential benefits deriving from environmental functions will not be an easy task. Many functions remain very difficult to identify, and most are not well-represented in any market. Non-market values (biodiversity, toxic buffering, flood control, waterfowl habitat) in most cases predominate, and where market values are present, they have proven very difficult to isolate and to attribute to particular aspects of the wetland environment. This suggests that attempts to internalize "environmental" values into conventional economic models will immediately confront serious problems of information gaps at all scales, just in identifying the presence of biophysical functions, and will certainly encounter problems in matching them to the valued benefits which they support.

Establishing the Presence of Functions

What environmental functions are present? Because of the range of different functions supported by any environment, it has proven time consuming in all of the case studies to identify the inventory of functions, whether present or absent in a particular area. While some were relatively easy to initially document, based upon direct observation (forest cover), or the existence of prior studies (fish habitat), others could not be readily discerned (groundwater recharge, life-support for individual species), (Bardecki 1988). Even in an estuarine marsh, the Cowichan, which, according to many experts contacted in the case study "had been studied to death", (it was chosen because of this) the data bases did not exist to permit clear assessment of the role of the wetland environment in the broader regional ecosystem (although there was good information on its role as fish and waterfowl habitat) (Ferguson et al. 1989). Even for the variables most important to the productive enterprise of the owners (agriculture in the Prairies, forestry in Greenock Swamp), the field studies uncovered little useable data on basic biological and physical characteristics (soil depth, organic material, etc.), and none on trends in the stocks of this base resource. While some regional data on resource stocks were encountered in each of the studies, (for example, forest stands, fish stocks) there is virtually no widely available information on a consistent national or regional basis on many of the basic elements of the environment (soil quality, water quality, organic material, habitat use) (Manning and Bond 1991). While in some localities, or for particular larger project where it can be compiled directly by the proponent, this type of information can be gathered, it is not available as a baseline for larger scale analysis.

Identifying the Links between Functions and Social Goals

What human goals are met by the functions of this part of the environment? In the wetlands pilots, efforts were made in each study to document the existence of social goals which could be linked to the functions supported by the wetland environment. Because three of the four studied jurisdictions lacked comprehensive long-term planning instruments, it was necessary to compile the list of goals from a broad range of sources: local plans, conservation authorities, water boards, Provincial standards for water quality, lists of endangered species and their habitat needs, particular studies which had defined a demand for a specific recreational experience or product, etc. Often goals for these were not clearly articulated, and in most cases no quantitative measure, threshold, target etc. had been established. As a result, the estimation of need was very difficult. How many ducks, how much water, how much access to waterfront, how much visual diversity is needed or desired? By the local community? By the larger region? Without some measure of demand, we are left largely without a means to establish which environments or which attributes of which environments are important. Some means to identify demand necessarily precedes any attempts to establish value in any substantive (quantitative) terms.

Assessing the Benefits Deriving From Specific Attributes of the Environment

Which parts of the environment provide the benefits? While the field pilot studies were relatively successful in identifying the presence of certain attributes of the particular environments studied, and, in a number of cases, the dependencies of certain benefits on these attributes, it proved much more difficult to assess the particular relationships. For some of the commercial products, models existed to permit estimation of the sensitivity of production to changes in attributes of the environment (for example, commercial crops relative to soil acidity or water availability) but few of these models were specific or validated to wetland environments. For a majority of the products and services derived from wetland environments, no empirical information on productivity-response relationships could be found. For example, few measures were located to relate ability to support nesting habitat, flood control, toxic absorption, recreational uses etc. directly to specific attributes of the environment (for example, water levels, chemistry, vegetation, proximity of other uses).

Analyzing Sensitivity of Benefits to Alterations

How much can we change the environment before we lose or compromise the important benefits we now obtain? Compounding the difficulties listed above is the concept of sensitivity to disruption or change. Even where some information could be found which showed that a valued benefit was derived from the existing wetland environment, it proved nearly impossible to identify the sensitivity of that benefit to changes in the wetland. If we lower the water (how far?), do the ducks leave? How acidic or polluted can it get before it no longer has the visual attributes which draw tourists? How much can be filled before it can no longer act as breeding habitat, groundwater recharge, or swimming hole? The answers to these types of questions are critical to the ability to identify which environments, and which attributes of which environments contribute to the benefits at local, regional, larger scales. Yet means must be found to identify these linkages if clear understanding of the environmental "stocks" is to occur. Also, alteration to stocks though drawdown or degradation (or enhancement or rehabilitation) is marginal change and cannot be portrayed even for marketed commodities by simple reference to average values of all stocks.

The Supply Constraint Concept

Is it possible to model or analyze the relationship between the characteristics of the environment and its capacity to support changing demands on it? Where it is possible to identify the relationship of production of a benefit (good, service) to particular attributes of the environment, the use of supply constraint modelling can give a good picture of which parts of the environment are critical to the satisfaction of particular demands, and what is likely to happen to that ability if particular parts of the environment are removed (built on, degraded) or altered (polluted) so that their ability to produce that good or service is altered. The Land Evaluation Group at the University of Guelph has developed a method which both identifies the opportunities and constraints associated with particular environments and permits the testing of various demand scenarios against the known characteristics and capabilities of the environment (Land Evaluation Group 1983a and 1985).

At least for a limited number of products derived from the environment, it is possible to assess the capabilities and trade-offs within a spatial framework. For principal crops in Ontario, the Guelph team has been able to estimate overall productive capacity, given the known productivity response for key crops to changes in selected biophysical factors (Land Evaluation Project 1982). It has further demonstrated from which areas with which characteristics this production must most likely come. On this base, a number of scenarios have been tested involving changes to the resource base in different localities (climate change, legislated limits) and changed demand patterns (self-sufficiency, increased production of fuels from biomass). The results have been useful to identify the potential *limits to production*, the *localities which are most critical* to successful satisfaction of particular demand scenarios, and the *production systems which are most sensitive* to different policies (Land Evaluation Group 1983b and 1985). A test of this approach in the province of New Brunswick showed that it is feasible to expand the modelling approach to the forest sector (Smit and Brklacich 1985). In work for the International Institute for Applied Systems Analysis (IIASA) (Manning 1988), an attempt was made to expand this approach conceptually to a continental scale and to encompass a broader range of valued products and services. The principal constraint to broader application of this approach lies in the paucity of data for many sectors, and the problems associated with standardizing baseline biophysical data across jurisdictional boundaries. What it demonstrates, however, is the central need to identify the products, services and experiences which are valued by society (not to mention particular cohorts of society, which greatly complicates the exercise) in order to choose what demand scenarios are realistic to solve for; this then helps to select which attributes of the environment, and in which localities, are the key stocks (capabilities) to long-term ability to service these demands.

Applications to Environmental Accounting

Environmental accounting cannot exist without a broader frame of reference which provides the parameters against which any accounting must occur. The selection of which attributes of the environment need to be incorporated into any accountancy framework is not independent of the selection of perspective and priorities. Thus trees become an important stock to include in the accounts only if humans (or if one wishes to take a non-human centred approach -- ecosystems) require their presence to serve a need or to satisfy a want. The difficulties experienced in the wetlands work in determining, even at the local scale, what the wish list was for goods, services or experiences to be served by the environment (or any part of it) translate into a serious initial barrier for design of any environmental accounts. Only when the choice has been made regarding what it is desirable to sustain is it then possible to begin to choose which attributes of the environment need to be part of the accounting procedure -- to allow accounting to incorporate those attributes which are most critical to an acceptable outcome.

Accounting Within a Framework of Sustainability

If sustainable futures, or system sustainability is to be our goal, then our approach to accounting at the national or more local level must be modified to support all of this goal. This paper concludes by addressing the need to establish an overall framework for the understanding of sustainability at all scales to allow effective building of national and regional accounting procedures which are responsive to overall, long term ecological and environmental concerns -- no matter what philosophical approach is taken to the role of humans in the outcome. One such sustainable development framework (Manning and Bond 1991) conceptually portrays the human/biosphere relationship as a supply/demand relationship, with the environment as the unique source of supply of the functions needed to support the demands for goods, services and experiences of (primarily) humans (Figure 1). The ability of the ecosphere or any part of it to continue to support the production of goods and the maintenance of services and experiences is contingent upon it retaining certain bio-physical characteristics. These are shown on the left of the model as the basis of carrying capacity for different uses. On the right of the model, population is shown to be the driving force for demands, modified by the expectations and attitudes of different societies. Because the natural products and services supplied by the environment were seldom what was wanted where it was needed, humans have created transformation processes to alter the natural resources and to transport them where they are desired. Human history can be characterized as the history of a species which tried to modify the environment to satisfy its demands,

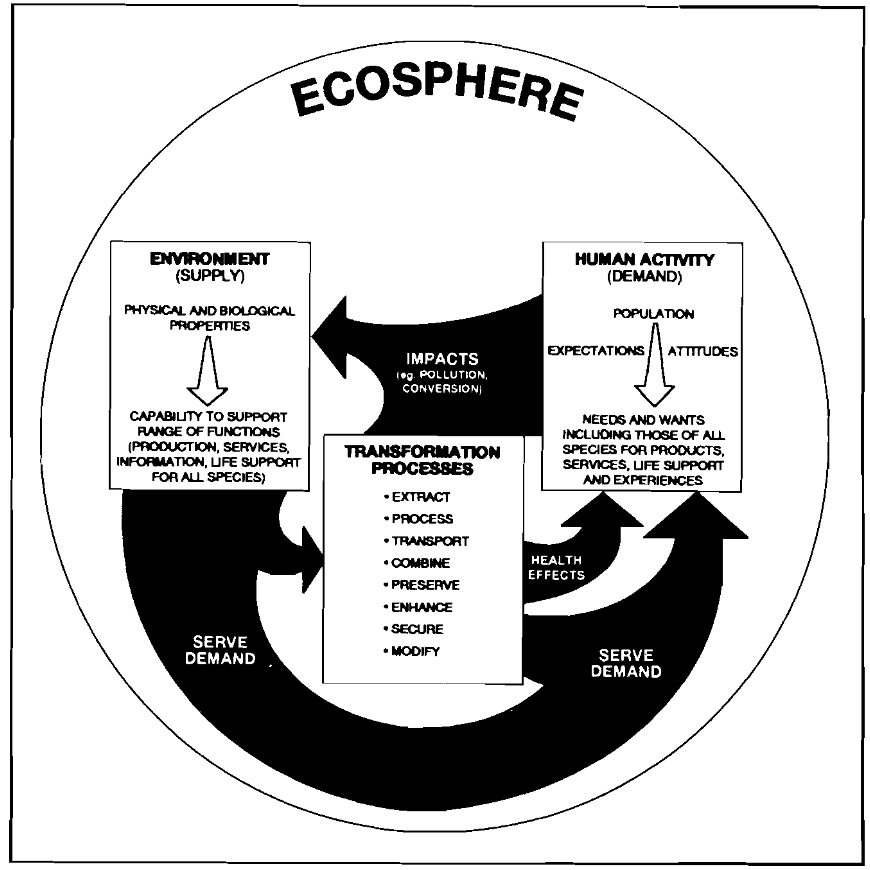

FIGURE 1 Towards a Sustainable System
Source: Manning et al. (1990).

rather than to suit its demands to the environment. Any attempt to document and evaluate the changes in the supply of environmental resources therefore needs to be framed in terms of the ability of the system to continue to supply all of the needs articulated on the demand side. These, of course, change over time as population numbers change, as the definitions of what is needed or wanted change, and as new perceptions and ideas (such as social and intergenerational equity, or deep ecology) cause us to alter the wish list, or at least the ranking of priorities on that list.

Feedback mechanisms are also important to monitor, as these can affect many of the attributes of the environment upon which the satisfaction of demands is most dependent. While some work has been done to in effect reduce the net value of some current resource stocks because of the negative impacts of, for example, pollution or erosion, (Fisher and Krutilla 1974;

Hartwick 1990) these efforts do not encompass the range of important impacts which can be caused by human activity (Krutilla and Fisher 1985). With reference to our accounting procedures, we clearly need to have the ability to monitor and relate changes in all parts of the model. Information on many attributes of the resource base, particularly those critical to the service of basic needs is essential. Similarly we need to monitor the changing demands of local, regional and global communities which may need to be satisfied by each part of the resource base. The productivity-response relationships for principal products and services supported by the environment need to be far better known, to permit us to understand the sensitivity to changes in the characteristics of specific parts of the environment (for example, Smit and Brklacich 1985). Information is also required on the impacts of human use of parts of the environment -- particularly how the management schemes and byproducts of our technologies affect the key biophysical variables and through them, the continuing capability to support other environmental functions. Management of a sustainable system will involve knowledge of, and attention to all parts of the system; management of the environmental supply, management of human demands on it, and the modification of our technologies to reduce negative feedbacks. We need to seriously reconsider the scale and boundaries of many of our institutions to better enable them to comprehend and manage on an ecosystem basis. It is only within a whole-system approach that sustainability can be defined, in response to a particular set of defined needs and collective aspirations of the inhabitants of the system. What we seek is solutions which are both biophysically feasible, and socially desirable. It is only with knowledge of all parts of the system that a satisfactory outcome can be devised, and hopefully achieved.

Conclusion

The purpose of this paper has been to challenge some of the contemporary approaches to environmental accounting, and to support the need to view environmental accounting as a building block in a larger process -- to support decisions which lead to a more sustainable system. Is it useful to better understanding, and are the proposed modifications likely to contribute in a positive way? For this reason, it is important to assess whether addition of satellite accounts to the existing system, or the creation of a parallel evaluation process will lead most effectively to useful and holistic understanding of these values. Approaches which attempt to build on the currently well-ensconced national accounting process will likely be easier to accomplish in the shorter term but will likely be very limited in their scope, dependent upon integrating information on stocks of currently-marketed products and services. While this can be an initial building block, a central concern must be the impression that the adjustment of national accounting procedures to incorporate a limited selection

of environmental values will adequately address the more fundamental valuation problem. The worst case scenario is that efforts (and funding) will cease once a few modifications or satellite accounting procedures are in place. Yet all environments are multi-purpose environments supporting many products, services and experiences, and many of the attributes most central to long term system stability are difficult, if not impossible to quantify in terms compatible with national accounting procedures. The elements which will therefore be omitted will likely include equity (social, intergenerational), life support, system stability, buffer functions, aesthetic and existence values, and non-market productive functions. One could argue that these can be more important in the long run to overall system sustainability than the measures of stocks which are amenable in the short term to inclusion in such satellite accounts.

Environmental accounting is an important step in bringing additional values to the current decision process. Because environmental accounting in practice can deal effectively only with parts of the whole model of sustainability (measuring flows and sometimes stocks) it must be viewed within a more holistic decision support system -- perhaps measures of a "*basket of environmental goods*" comprised of a number of discrete indicators which reflect the broadest range of values derived from the environment. At the regional level, *an ecosystem approach* may be even more necessary than for larger national or international levels requiring monitoring and measuring of all parts of the environmental supply/human demand relationship, with the added aspect of having to contend with boundary flows. In the shorter term, as we seek to address these concerns, it will be necessary to seek a range of *meaningful indicators* and to ensure that decisions do not depend on a too-limited integrated" black-box" which seems to provide more solid and holistic answers than it is able to deliver. The closer one looks at the swamp, the deeper and more complex it is seen to be; our murky models do not yet do it justice and the opaque soup of our values may still hide more than it reveals.

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