THE ECONOMIC VALUE OF THE ENVIRONMENT:

CASES FROM SOUTH ASIA

INTRODUCTION AND OVERVIEW

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INTRODUCTION AND OVERVIEW

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The use of environmental economics tools is often advocated as a means of ensuring the sustainable management of the natural environment. This paper is intended to help public officials and environmentalists understand what those tools are how they it can contribute to environmentally-sensitive growth and economic decision-making. The paper provides a basic introduction to the role of the environment in the economy and explains why the free market will not lead to efficient or environmentally sound resource use. It then describes three related information tools which economists have developed which can help address this problem; monetary valuation, social cost-benefit analysis, and environmental accounting. Finally, it introduces the case studies in the rest of this volume, which illustrate the use of these tools to answer real policy questions in South Asia.

One caveat is important at the start. This paper describes the "pure" economic approach to the environment. This approach is wholly anthropocentric. "Pure" economists would only be interested in value to humans operating in an economic system, as expressed by their choices between spending their money on the environment and spending it on other goods and services. In purely economic analysis, the concept of the "intrinsic" value of the natural world has no meaning. If no one is willing to pay for the good or service in question, it has no economic value, even though it may be essential for other purposes such as preserving ecological balance or providing life support to non-human species. This does not mean that something like biodiversity is entirely left out of our analysis. However, its economic value arises only to the extent that humans are willing to pay for conservation, not for any reasons intrinsic to the natural world.

Economists, being human, recognize that this is a limited concept of the value of the environment; it is merely the concept supported by pure economic analysis. Economic analysis should be only one element in policy decisions about the environment (or about the economy). We must combine it with political, social, moral, and other values-based criteria for analyzing the options before us. That being said, economic approaches have a great deal to contribute to making resource management decisions; it is simply necessary to understand their limitations as well as their strengths. Neither this paper, nor most economists, would advocate that decisions be made on purely economic criteria.

INTRODUCTION: ECONOMIC FUNCTIONS OF THE ENVIRONMENT

In the traditional economic framework, output is a function of three factors of production; land, labor and capital. Land is broadly defined to include space for building, fields for cultivation, and natural resources such as forests and water bodies. The main emphasis of economic development strategies has been on labor, capital, and the agricultural use of land. The natural resources associated with land have been treated as a given, to be used for human benefit with little attention to the sustainability of that use. Moreover, economic growth has been given primary importance, with little attention to its impacts on the environment or the sustainability of the resource base.

In the past, this approach was reasonable. Until the industrial revolution and the associated rapid population growth, human impacts on the environment were negligible. Pollution was localized, and

resources were generally adequate to provide food and shelter to those who needed them. While life spans were shorter and material well-being lower, that was not due to natural resource constraints or environmental problems. In the past two centuries, it has become increasingly clear that human impacts on the environment may be irreversible and may in time limit our own ability to continue to thrive on earth. Over the past three decades, concern about this problem has grown worldwide. The search is now underway for strategies to minimize our impacts on our surroundings while improving the quality of life of the billions of people living in poverty.

When the environment movement began gaining strength in the 1960s, it was perceived to present a trade-off between improved standards of living and a clean environment. Increasingly, however, both environmentalists and development advocates are recognizing that to maximize living standards in the long run, we must protect the environment. Improvements in the well-being of much of the world's population depend on finding ways to use our resources without destroying them.

The fields of environmental economics and ecological economics are both responses to this challenge. They constitute economists' strategies for ensuring that the decisions of individuals, firms, and governments reflect the economic importance of the environment and that the development paths we choose will be sustainable.

The environment plays four crucial roles in sustaining economic activity:

- life support
- supply of raw materials
- absorption of waste products
- supply of amenity services

Life support: The environment provides the biological, chemical and physical systems within which human life was created and on which human life depends for its survival. This includes, for example, the air which we breath, the hydrological systems on which we depend for water, and the soil fertility which allows us to grow food. While human populations can rebound from slight degradation of these services, they would not be able to survive without them.

Supply of raw materials: The environment supplies the raw materials and energy necessary for economic production and household activity. Some raw materials, such as forests, are renewable; stocks grow naturally, and humans can expect a constant supply if we choose to harvest at sustainable levels. Others, such as minerals and fossil fuels, are nonrenewable; once consumed they cannot be regenerated, so we have to plan for their replacements as we use them up.

Absorption of waste products: The environment acts as a "sink" which absorbs the waste products of economic and household activity. Modest quantities of organic waste can easily be absorbed by the environment and degraded through natural processes. However, there is a limit to the quantity of effluent which natural systems can handle; beyond a certain level ecosystems can no longer disperse, dissolve, or degrade the materials dumped into them. Moreover, wastes such as radioactive materials or some toxic chemicals are difficult or impossible to absorb even in small quantities. If history is a guide, the larger the economy gets, the more waste will be produced relative to the limited capacity of the environment to absorb it.

Supply of amenity services: The environment provides amenity services, such as scenic beauty, which are enjoyed by humans in their outdoor activity. Although important for psychological well-being, these amenities are not indispensable for continued physical existence. Because most people value them,

however, they can be a source of revenue which is sometimes sufficient to make it financially viable to ensure that they are protected; thus they can be of substantial economic importance.

MARKET FAILURE: THE ECONOMIC CAUSES OF ENVIRONMENTAL DEGRADATION

The field of economics is concerned with how markets allocate scarce resources among users. Several assumptions about how markets work underlie most economic analysis:

- The allocation of resources is based on consumer preferences, the distribution of wealth, and the costs of production.

- Consumers are rational. They choose among goods and services based on prices, the amount they can spend, and their preferences. The value which a consumer places on additional consumption of a good declines with increasing consumption. That is, a consumer who already has a lot of a particular good will not be willing to pay much for more of it, whereas a consumer with none of it might be willing to pay a lot for it. Economic rationality dictates that consumption of a good continues up to a point at which the value placed on an additional unit is equal to its price.

- Firms seek to maximize their profits. This implies that they will minimize their costs in order to produce efficiently.

- Competition among firms forces them to charge prices that are equal to their marginal costs of production. The "marginal cost of production" is the cost of producing one more unit of a particular good. If it is less than the price, the firm can make money by producing and selling more; once it exceeds the price, they would lose money by producing more. Therefore they produce to the level at which price equals marginal cost.

- Most goods sold in markets are "rivalrous;" that is, one person's consumption reduces the ability of others to consume the same good. This is clearly true of ordinary products like food or clothing. It is not true of others, however, such as the system of national defense or a radio broadcast. Some non-rivalrous goods, like defense, are therefore provided by the government. Others, like radio, can be provided privately, but must be funded through advertising.

- Goods in the market are "exclusive;" that is, producers can prevent people from consuming their products if they haven't paid. This is true of most conventional goods purchased in markets.

- Many non-exclusive goods are also non-rivalrous; these characteristics tend to go hand in hand. Our examples of non-rivalrous goods, defense and radio, are also non-exclusive, because there is no reasonable way to prevent those who don't pay from benefitting from them anyway.

- Some non-exclusive goods are not non-rivalrous, however. For example, walking on a crowded city street is rivalrous because each additional person imposes more congestion on the others; but it is not usually realistic to exclude pedestrians if they have not paid a toll to be there.

The field of environmental economics exists because the assumptions of the market economy do not always hold where the environment is concerned. In particular, environmental goods and services are often non-rivalrous, non-exclusive, or both, making it difficult to force those who use them to pay for them. *The differences between the "perfect" market and the environment constitute the fundamental reason why economic activity leads to environmental degradation.* These differences create the need for

the field of environmental economics, as well as for public policy interventions to allocate environmental resources through non-market means or to correct the market failures.

Externalities

One discrepancy between the theoretical market economy and the way the environment is handled in the real world stems from what economists term "externalities." In the theoretical market, the manufacturer must pay for all of the materials and services used to produce outputs, including the disposal of waste. Similarly, the price which a consumer pays to buy something covers all of the costs of its production and disposal. In the real world, however, this is not true. The manufacturer must buy the machinery and raw materials required to produce goods, but typically does not pay the full cost of waste disposal or energy use. The disposal of wastes or burning of energy uses up waste assimilation services of the environment which the manufacturer does not pay for. The same is true of a consumer who drives a personal automobile that emits fumes or who purchases food wrapped in plastic that is then dumped in a landfill.

Economists term these unpaid costs "externalities" because producers and consumers can make decisions without having to take them into account. More technically, an externality may be defined as the effect of one economic agent on another which is not controlled by market operations. Because the waste disposal services of the environment are usually free, people will consume more of them than they would if they had to pay for them. This is considered to be a market failure, because in the absence of a price, the market allocates these services inefficiently.

The economist's response to this problem is to seek a way to "internalize the externality" – that is, to force those who use the resource to pay a price for it which reflects the cost to society of its use. At that price, people would choose to use the environmental service at an economically efficient level, the level at which price equals marginal cost. Note that the economist is not concerned with preventing all use of the service (i.e. preventing all pollution), nor with preventing all environmental degradation. Rather, the economist's objective is to set the price at the level at which it equals the costs imposed by pollution. This price will permit a modest amount of waste disposal, allocated through the market to those who are willing to pay the price rather than through a regulatory process.

Conceptually, internalizing externalities is an efficient and elegant way to allocate environmental services. In practice, designing mechanisms through which to accomplish this can be quite tricky. It is difficult to quantify the cost actually imposed by the environmental degradation, a subject which is discussed further below. Politically, it is often impossible to introduce the fee-based measures which can be effective in internalizing externalities. Environmentalists sometimes object to the idea of selling the "right to pollute," preferring that no pollution be allowed. Those responsible for the pollution - both producers and consumers - often object to having to bear the full costs of their actions, arguing that it will cause harm to the economy and hardship to individuals.

Common Property Resources

Common property resources are those which are rivalrous but non-exclusive. That is, it is hard to prevent individuals from using them, but each additional user imposes costs on all the others. Typical examples are marine fisheries and grazing lands. In the case of these natural resources, there is some maximum sustainable yield at which the resource can be harvested without hurting future harvests. If there were only one user who sought to continue using the resource indefinitely, s/he would use it at that level but no higher. However when there are many users, each has a direct incentive to take as much as possible, even though the overall combined outcome is an unsustainably high level of use which depletes the resource.

This kind of resource is a classic case of the prisoner's dilemma. Every user of the resource is better off if they all take less to keep total use at the maximum sustainable yield. However, if they don't have perfect information about each other's actions and don't trust each other to practice restraint, then each will assume that the others are going to use as much as they can. If the others are all going to take as much as they can, then each individual can only gain by doing the same him or herself. The result is that each one takes all s/he can, and the resource is depleted. This has been referred to as "the tragedy of the commons," a term coined in a seminal article which described the problem and which has become a classic in the field (Hardin, 1968).

Common property resource use can also impose externalities on others who are not involved with the resource. For example, overgrazing might lead to increased soil erosion, which in turn could cause siltation of nearby rivers and harm to fresh-water fisheries. However, the key feature of the common property resource is not the externalities it imposes on non-users; it is the long-run cost to all resource users if a sustainable management strategy cannot be designed.

Analysts of common property resource issues have suggested a number of possible policy responses to the risk of resource depletion (Ostrom, 1990). One is full public sector management of the resource, in a system wherein the government determines who can use the resource and in what quantities, imposing penalties on those who cheat. This approach has been taken in many countries to control access to resources such as forests. It assumes that the government has perfect information about the resource and can administer the system effectively and efficiently; clearly these assumptions are often incorrect.

An opposite strategy is to privatize the resource fully, so that it is managed through the market as a pure private good. Consider an area of pasture where rain will fall in different areas each year. Dividing the land into private parcels will increase the risk of drought faced by each herder. With one large shared parcel, all herders will have access to some well-watered land, although they may be crowded. With divided parcels, each year some herders will have no grass while others are doing fine. Instead of each animal having a smaller share, some will have excess and others will die. Moreover, for a mobile resource like a fishery, it may be hard to specify exactly what is meant by individual private ownership.

In a third approach, resource users enter into a voluntary binding contract with each other concerning use of the resource, with a designated third party having the authority to enforce it with known consequences for cheating. Ostrom uses detailed case studies to identify the circumstances under which such a strategy could effectively protect common property resources from depletion (Ostrom 1990).

Policy Failure

In addition to market failure, government policy can also be a cause of environmental damage. In some markets, the prices of environmental goods and services are lower than their marginal cost because governments offer subsidies for their use. This creates an incentive for overuse of the resources, thereby hurting the environment. Examples of such "perverse subsidies" include public support for logging roads in the United States, subsidies for expansion of the fishing fleets in many coastal countries, and low prices for imported fuel in many developing countries.

VALUING ENVIRONMENTAL GOODS AND SERVICES

Because the market system does not set a price for most environmental goods and services, economists have developed techniques for imputing monetary values to them. Such estimates are fundamentally

aimed at understanding individuals' potential willingness to pay (WTP) for goods and services which they now receive for free, or their willingness to accept compensation (WTA) for losing such goods and services. The goods and services in question could include a range of things; entrance into a park, a pristine view from a mountain top, the right to discharge municipal waste into a river or automobile exhaust into the air, or simply the knowledge that tigers are flourishing somewhere in the world even though one never expects to see them.

Willingness to pay and willingness to accept differ in their assumed baseline. If we analyze willingness to pay, we assume that the potential buyer (who could be an individual consumer or a producer) now doesn't have the good or receives it for free, but would have to pay for it in the future. The price they would be willing to pay will depend on their income, how much the item is worth to them, and the price of substitutes. Thus if a country proposes to begin charging admission to its national parks, they will want to analyze how much its citizens would be willing to pay in entry fees. This WTP could be a function both of the income of the citizens and of the cost of other recreation opportunities.

If we analyze willingness to accept compensation for loss of a service, we assume the consumer now has the service and we are proposing to take it away and compensate him or her for its loss. For example, suppose a coal-fired power plant is emitting carbon into the air without having to pay for the disposal services of the environment. A system of carbon permits is introduced in which the plant is granted free permits equivalent to its current pollution. It can either use those permits and continue polluting, or sell the permits to someone else and reduce its own pollution. The price at which the plant will sell its permits – that is, its willingness to accept compensation for giving up its right to pollute – will depend on the price of equipment with which to prevent the emissions. In order to give up the right to pollute, the plant would have to receive at least enough cash to cover the costs of the substitute, i.e. the pollution control equipment.

What are we valuing?

In the first section of this paper we listed four services which the environment provides; life support, raw materials, waste disposal services, and amenities. Conceptually, what we do when we put an economic value on a particular environmental asset such as a forest is to identify each of the individual services which it provides, place a value on it, and then add up the values to calculate the total value of the forest. Of course using some services of the forest may preclude using others. For example, if we cut down the forest for timber, then it cannot provide life support to mammals and birds or amenities such as recreation. Our total value must be for the forest as used for a given set of goods and services which are compatible with each other.

Economists have organized the services of the environment into a standard presentation in developing a framework for valuation. The point of departure is that we want to estimate the total economic value (TEV) of an environmental asset. TEV is broken down into use values and non-use values:

TEV = use value + non-use value

"Use values" are clearly identifiable human uses of the environment. This includes direct use of raw materials, both of marketed products such as timber and of non-marketed products such as gathered fuelwood, most water extraction, soil, and so on. It also includes so-called "indirect uses" of the environment, such as waste disposal, amenities like recreation or scenic vistas, flood protection, water filtration by submerged aquatic vegetation, and so on. By and large the indirect uses are not marketed, though access to parks is a notable exception. Thus:

use value = direct use value + indirect use value

Non-use values of the environment capture our WTP (or WTA) simply to know that the resource will continue to exist, even though we don't expect to use it – or even see it - at any identifiable point in the future. For example, some people are willing to pay to help ensure the existence of the royal bengal tiger of Sunderbans in Bangladesh. This is termed existence value. A related form of non-use value is termed option value; this would be the WTP for the option to come see the tigers at some undetermined point in the future. Some economists also identify what they call quasi-option value. This is the expectation that the value of the option will increase over time, as the tiger (or other environmental good or service) becomes more scarce. Yet another non-use value is bequest value; in this example, it would be the willingness to pay to ensure that future generations would be able to see the tigers. Thus:

non-use value = existence value + option value + quasi-option value + bequest value,

and to sum up:

TEV = direct use value + indirect use value + existence value + option value + quasi-option value + bequest value.

The example of a tropical forest is useful for identifying what the different kinds of value might be in practice. The table below lists many possible goods and services which we could obtain from the forest:

Table 1. Total Economic Values of a Tropical Forest

Direct uses	**Indirect uses**	**Option Values**	**Existence Values**
Timber Wild plants Hunted animals Medicines	Recreation Wind protection Air pollution control Watershed protection Nutrient cycling Carbon fixation	Future direct & indirect uses	Willingness of westerners to support protection of tropical forests, e.g. based on moral conviction

Table 1 gives an idea of the various values associated with an environmental resource. The next step is to estimate the economic value of each of these services.

How can we value it?

Economists have developed many methods for valuing the non-marketed services of the environment. No one method is suited to all services, meets all theoretical criteria, and can always be applied with readily available data. Rather, it is necessary to choose among methods for each service, based on what is appropriate and feasible.

In discussing valuation, it is important to distinguish between stocks and flows – that is, the valuation of an environmental asset (the stock) and the valuation of the flow of services which comes from that asset. Using the forest example, we can identify a distinct asset and an associated flow of services for each of the values described above. One service provided by a forest – the one which receives the most attention because it happens to be marketed – is timber. The forest could be seen as a productive asset from which some number of trees can be harvested each year for timber without reducing the productivity of the asset in future years. The sale price of these trees would be the value of the flow of services from the timber

asset. Alternately, the timber in the whole forest could be given a value; this might be the price at which it would sell on land markets. In an efficient market, the price of the timber asset should be the present value of the income stream which would result from sustainable management of the forest for timber purposes.

This distinction between stock and flow applies to any good or service provided by the forest, whether or not it is currently marketed, just as it applies to timber. Valuation can be done in either stock or flow terms, depending on what is most useful for the analysis. What is essential, however, is that when comparing different management systems or summing the values of different services, they be in the same terms, so that we don't find ourselves comparing stocks of one service with flows of another.

One set of valuation techniques depends on using market data for related products to estimate a price for environmental goods and services. These techniques include dose-response analysis, consideration of defensive expenditures and substitute goods, travel demand analysis and hedonic pricing.

Dose response: The dose-response method, borrowed from medical analyses of the health impact of increasing levels of medicine, measures the impact on economic output or expenditure of increasing environmental degradation. It is typically used to estimate the impact on agricultural output of increased pollution, soil erosion, or other incremental change. The decrease in the value of crop may be understood as a proxy for the costs of pollution or of farmers' willingness to pay to prevent it.

Defensive expenditures: Defensive expenditures are those made to protect against the impacts of environmental degradation. For example, the cost of boiling and filtering drinking water may be considered a defensive expenditure. These may be understood as a lower bound (or minimum estimate) on the cost of pollution and willingness to pay for preventing it.

Substitute goods: In some cases there is a private market for goods which are also available "free" from the natural environment. For example, in many areas people can either use their time to gather fuelwood, food, and medicinal plants, or they can use their money to purchase close (or identical) substitutes in local markets. The price in the local market is often used as a proxy for the value of the gathered resource. There is a significant income effect at work here, however. People who gather such resources are often living in a largely non-monetary economy, raising much of their food and other material needs and lacking money with which to buy goods. The price of marketed substitutes therefore constitutes an upper bound (or maximum estimate) on their willingness to pay for the goods, since at that price they are in fact choosing to gather "free" goods instead of purchasing them.

Travel demand: The travel demand method has been developed as a way to estimate willingness to pay for recreational amenities provided by the environment. It involves using data on distances traveled and expenditures for travel to estimate a demand curve for a specific national park or other natural site. From the demand curve, the analyst can estimate the actual willingness to pay for the recreation experience at the site.

Hedonic pricing: Hedonic pricing techniques use regression analysis to determine the contributions of different characteristics of a good to its price. This technique has been refined in the analysis of housing markets. The price of properties is estimated as a function of their different features; number of bedrooms, square footage, lot size, neighborhood characteristics, and so on. This method can be used to determine the contribution of a clean or quiet environment to the value of a home. It can also be used to identify the wage premium paid to workers in dangerous or polluted environments.

Another set of valuation techniques involves asking direct questions about preferences and willingness to pay for environmental goods and services. These techniques are generally referred to as contingent

valuation methods. Interviewees are asked how much they are willing to pay for a given good or service or how much compensation they are willing to receive to tolerate a cost or the loss of an environmental good or service. Respondents indicate the maximum they would be willing to pay for an environmental improvement or the minimum they would willing to accept for the decline in environmental quality if a market existed for the good in question. In the contingent ranking method respondents are asked to rank several alternatives rather than directly expressing a willingness to pay or to accept.

The advantage of contingent valuation methods is that they provide information about exactly the question of interest rather than depending on proxy markets. The disadvantage, of course, lies in the unreliability of respondents' information about their own willingness to pay, either because they simply have no idea and find the survey confusing, or because they are lying in order to influence the study results in one way or another.

COST BENEFIT ANALYSIS AND DISCOUNTING

Cost benefit analysis (CBA) is founded on the simple and rational idea that decisions should be based on comparing the potential advantages and disadvantages of an action. CBA uses market costs and benefits to determine which projects contribute most towards the growth objectives of the economy, independent of who the beneficiaries are.

Social cost benefit analysis (SCBA) tries to improve decision-making by factoring in other issues in addition to market costs and benefits. Such issues may include who benefits from or pays the costs of the proposed project. This is addressed by weighting the costs or benefits to particular groups differently and by factoring in specific impacts such as those on women or other target groups. In addition, SCBA often uses so-called "shadow prices" instead of local market prices to calculate the costs or benefits of proposed actions. Shadow prices are considered to indicate actual willingness to pay for goods and services, whereas local market prices are often fixed, subsidized, or for other reasons do not reflect willingness to pay. Shadow prices may be based on world prices, or they may be adjusted to eliminate the impact of public subsidies.

Environmental valuation studies may constitute the basis for establishing shadow prices for environmental goods and services which are not sold in markets, so that they may be included in SCBA. This makes it possible to compare the different strategies for managing a resource such as a forest, taking into account the fact that not all services of the forest can be used at once. Thus if it is proposed to log a forest, clear the land, and plant crops, the SCBA would compare the set of goods and services available if that plan were put into effect with those available if the forest were managed for sustainable timber production. Some of those goods and services would be marketed, such as the timber (under both scenarios) and the crops (under the clearcut and plant scenario). Others would not be, such as recreation opportunities in the forest, prevention of soil erosion, habitat conservation, and so on; those would be available only under the sustainable management scenario.

The comparison of the value of the forest under the two different scenarios would tell policy-makers which use of the forest would contribute more to the economy. The results of this analysis will be different from the analysis of the forest owner, who cares only about private returns and is not interested in broader economic impacts or possible negative or positive externalities from decisions about how to manage the forest. It will also differ from conventional cost-benefit analysis, which considers all marketed impacts on the economy, whether they accrue to the forest owner or others, but does not consider non-marketed impacts.

When the SCBA of proposed forest management strategies is undertaken, we would have to estimate the

present value of the future income stream from each service of the forest under each management strategy. In the sustainable management scenario, all of the services will be provided each year into the future. In contrast, in the clearcut and plant scenario, there will be revenue at the start when the timber is sold, an investment at the start in order to convert the land to agriculture, and then an income stream into the future from agriculture. To compare the two strategies, therefore, we would discount all of the income streams back to the present and then compare the summed present values for the different scenarios.

This use of discounting raises questions about the choice of discount rate. The basic principle underlying discounting is that money earned today is worth more to us than the same amount earned a year from now, because we could invest today's earnings and they would be worth more in a year than today. Thus $100 today might be worth $105 next year, if the interest rate is 5%. In the same way the promise of $105 next year is worth less than that today – only $100, at the same 5% interest rate. Following this logic, any promised earnings in the future are worth less today than they will be when realized in the future. The return which we could hope to get on our investment determines the amount by which we would discount our future earnings. This is termed the discount rate.

The higher the discount rate, the less we value future benefits relative to today's benefits. The results of SCBA are therefore very sensitive to the choice of discount rate. An income stream of $2000/year over forty years is worth $34,318 today at a 5% discount rate, but only $19,598 at a 10% discount rate. The $2000 earned in the 41st year would be worth $270 today at 5% but only $40 today at 10%.

This sensitivity to the choice of discount rate tends to work against sustainable use of natural resources when decisions are based on cost benefit anlaysis. The benefits of selling off natural resources typically occur in the present, whereas the benefits of conserving them take the form of a perpetual income stream. Consequently, discounting can make it hard for sustainable management to compete financially with immediate use. Moreover, when we discount future income streams back to the present, we are interested solely in the value of the resource to people who are alive today. We do not try to take into the account the preferences of future generations with regard to the use of the resources.

If the resources in question are fully renewable, this is not a problem. If future generations prefer to have forests, for example, they could simply let them grow back instead of continuing to plant crops. Where this is the case, discounting is an appropriate analytical tool. In reality, however, very few resources are completely renewable, and some are not even partially renewable. Once extinct, a species is gone forever and cannot be brought back; once depleted, minerals are gone. While we can grow new forests for timber, it is not clear that we can recreate the complex and diverse ecosystems of old-growth forest. More complex strategies must be developed, therefore, to balance the income needs of the current generation against the rights of future generations to choose whether they wish to receive the benefits of the natural environment. This is essentially a problem of how to put a monetary figure on the bequest value of the environment, that component of non-use value which pertains specifically to future generations.

ENVIRONMENTAL ACCOUNTING

Environmental accounting (or green accounting) is the modification of the System of National Accounts (SNA) to take into consideration the economic role played by the environment. The SNA is a set of economic accounts which governments routinely compile in a standard format in order to track the activity of their economies. SNA data are used to calculate the major economic indicators of a country, including Gross National Product (GNP), Gross Domestic Product (GDP), savings rates, and income per capita. SNA data are used to track the progress of the economy, to analyze the causes of changes in economic activity, and to develop policy responses to economic problems.

The SNA is compiled using a standard framework developed, supported, and disseminated by the United Nations Statistical Division (UNSD) under the authority of the UN Statistical Commission. The international standardization of these accounts following the UN methodology is essential in order to permit comparisons across countries. Similarly, the fact that the accounts are calculated routinely, rather than just once, makes it possible to track how a country is progressing over time, and to compare its progress to global or regional trends. This provides a valuable basis for designing public policies to move countries and the world toward desired patterns of growth and development.

Environmental accounts provide data which highlight the role of the natural environment in economic well-being. They provide analytical information with which to assess claims about the costs of both environmental protection and environmental degradation. This can provide a more objective foundation for evaluating proposals which have an impact on the environment and for understanding what their actual impacts will be on the economy. The detailed data which underlie the accounts can help identify policy choices which further both environmental protection and economic growth.

Problems with the SNA

Several deficiencies in the national income accounts have received attention in recent years. Environmentalists and social critics argue that although the production of goods and services is recorded in the national income accounts, the harm caused to the environment by that production is not taken into account. Hence the major macroeconomic aggregates of the accounts are not an accurate indicator of well-being.

Statisticians and national income accountants counter this argument by pointing out that such measures as GNP and GDP are not designed to measure well-being; they are designed merely to measure the activity of the economy. In their view, therefore, the error is not in the calculation of such aggregates as GDP per capita, but in use of those aggregates as if they indicated our material well-being or even our happiness, when in fact they only indicate the level of economic activity.

Critics from both environmental and statistical perspectives point out a number of other problems with the accounts. One is that expenditures to protect the environment from degradation or to mitigate the negative environmental impacts of production increase the major indicators rather than decreasing them. Thus if water pollution forces us to spend additional resources on treating our drinking water, the national income accounts show us having more economic activity than we would if our water were not polluted in the first place. While water treatment does indeed create jobs, this is nevertheless somewhat counter-intuitive. Such defensive expenditures could be disaggregated within the accounts to highlight the costs incurred to prevent or mitigate environmental degradation, even if they are not subtracted out of income indicators like GDP.

Another problem is that, while the SNA subtracts the depletion of man-made capital as depreciation rather than counting it as income, the depletion of natural resources is accounted for as income. For example, a forest may be understood to be a productive asset from which an annual income can be derived through sustainable management. Cutting down one fourth of the forest each year for four years would bring in a high income in the short run, but would not be sustainable. However the accounts would simply show this as income, rather than showing that high revenues came in but the natural capital was depreciated rapidly as well. Similar depreciation should be recorded for soil erosion, fisheries, and other natural resources if they are managed unsustainably.

The SNA also does not usually record goods supplied by the environment which are not sold but which

are nevertheless of value, such as fuelwood gathered in the forests, meat and fish captured for consumption, and medicinal plants. (Many national accounting systems do, however, estimate the value of agricultural produce which is consumed by the farmers rather than sold.) Similarly, the SNA does not include unsold services of the environment, such as watershed production by a forest or water filtration by submerged vegetation.

Changing the SNA

There has been considerable discussion over the past thirty years of strategies for modifying the SNA in order to address these problems. A number of different approaches have been advocated, and a variety of issues addressed in these debates.

- **Physical vs. monetary accounts:** Physical accounts provide data about the stock of natural resources and their use; the size of forest or mineral reserves, the quality of water and air, the depth and chemical composition of the soil, etc. Monetary accounts, in contrast, place an economic value on those characteristics or their use, so as to understand the role they play in the economy. While physical accounts avoid the need for monetary valuation, they do not lend themselves to economic analysis or comparison. They are not a prerequisite to monetary accounts, but if they exist they will greatly facilitate monetary valuation of the environment.

- **Integrated vs. satellite accounts:** Integrated accounts change the calculation of GNP, GDP, and other key national indicators. Satellite accounts (of which physical accounts are one example) are linked to the SNA, but do not change either the calculation of key indicators or the central framework of the account. The advantage of satellite accounts is that they allow national income accountants to violate some of the conventions of the SNA in ways quite useful for environmental data, without threatening the consistency of the information in the conventional accounts. However, because they do not change GNP or GDP, they do not correct the distortions inherent in those indicators.

- **Methods of calculating natural resource depreciation:** True economic depreciation is the change in the present value of the future income stream from an asset from the beginning of the accounting period to the end. This is difficult to measure, however, so other measures have been developed as proxies. The "net benefit" method estimates annual depreciation as the change in the physical stock of the resource during the accounting period multiplied by the net revenue from extraction (average price less extraction cost). This method has been used to estimate depreciation of marketed products such as timber, as was done in the environmental accounts for Indonesia and Costa Rica developed by the World Resources Institute (Repetto et al ,1989; Repetto, Cruz, et al, 1991). The "user cost" method, which has been proposed for measuring the depreciation of non-renewable resources, identifies the share of revenue from sale of the resource which must be reinvested in order to maintain a permanent income stream equivalent to the return on the value of the resource. Any revenue above that may be considered income.

- **Inclusion of maintenance costs:** Maintenance costs are the expenditures that a country would have to make for its use of the environment to be sustainable. Some experts on environmental accounting argue that maintenance costs should be deducted from the accounts to get a correct level of "green" economic activity. Others are wary of this approach because such estimated costs are highly subjective. Moreover, subtracting them from indicators like GDP to derive a "sustainable GDP" can mislead users of the resulting indicator into thinking that those expenditures have actually been made, when in fact they have not.

- **Valuation of non-marketed environmental services:** Due to the difficulty and subjectivity of valuation, most environmental accounting pilot activities do not value non-marketed services. However, this is of great interest to environmentalists in many countries, so its inclusion warrants consideration, if only on an experimental basis in satellite accounts.

If green accounting is such a good idea, why isn't everyone doing it?

Modifying the SNA to integrate the environment could lead to significant improvements in environmental data and policy-making. However, a number of constraints have kept this from being done on a routine basis in most countries. First, an array of unresolved methodological issues must be addressed one way or another to build the accounts. Individual countries can and have chosen strategies for handling these questions in building pilot accounts. However, one great strength of the SNA is that the same methods are used worldwide, permitting international comparisons. Until the U.N. Statistical Commission officially endorses a set of methods for environmental accounting, or standards are accepted in some other way, many countries will not be willing to invest in routine production of environmental accounts, because they will risk being incompatible with a future UN system.

For some ten years the UN Statistical Division has been leading an effort to develop methods for environmental accounting which may eventually lead to such an endorsement. In 1993 UNSD published a proposed methodology referred to as the System of Integrated Economic and Environmental Accounting, or SEEA. This came out in conjunction with the official 1993 revisions of the SNA, but is only a preliminary work. National income accountants from a number of developed countries have been working for several years on refining the SEEA methodology, under the auspices of the so-called London Group, comprised of national income accountants and statisticians from developed countries. In 1998 the U.N. Statistical Commission asked the London Group to work towards producing a revised version of the SEEA, which is now underway. However it is still likely to be some years before the Statistical Commission endorses a methodology for environmental accounting.

A second constraint on the introduction of environmental accounting, particularly in the developing world, is the state of the conventional accounts and the lack of data on which to build environmental accounts. Many developing countries have been unable to put as much effort as they would like into the development of their conventional income accounts, nor have they been able to invest substantially in building the primary databases which would be inputs into environmental accounts. Consequently, their first priority is often the strengthening of their conventional accounts and data systems rather than expansion into the more experimental environmental accounts.

Environmental accounting can also be political. Detailed data on resource-based sectors can highlight their unsustainability, and subtracting the depreciation of natural capital from GNP and GDP can make the country's growth path look much worse than it appears from conventional indicators. These outcomes can lead the public to question national development strategies, while they can also generate strong pressure from resource-based industry groups to prevent further accounting work. This occurred in the United States in the early 1990s, when initial work on the minerals sector was met with strong opposition from industry groups, who successfully lobbied Congress to prevent the work from continuing. Accounting work in Chile was also halted when data were released that showed that the country's forest-based development strategy was not sustainable.

SEEA Methodology

Work on the design of environmental accounts has been underway since the 1970s. Some accounting

projects have focused only on physical data, seeking to avoid the uncertainties associated with valuation. Others have included monetary data, but have been organized primarily to provide input into sectoral policy analysis rather than to modify the national accounts. Where monetary values have been used, some pilot projects have been limited to depreciating marketed resources, such as timber, while others have also ventured into valuation of non-marketed goods and services.

The UN's SEEA is an effort to integrate many of the different approaches being developed and tested around the world into a broad modular framework which offers a range of choices for how to implement environmental accounts. The SEEA includes:

- **Natural resource accounts.** These include physical and monetary data on stocks of natural resources and changes in those stocks due to natural processes and human use – that is, depreciation of natural resources such as forests and soil. Such data may be used to answer questions about the contribution of natural resources to economic output, the impact of environmental catastrophes on the economy, the rate at which stocks are being depleted, and so on.

- **Emissions accounts.** These use the framework of the National Accounting Matrix including Environmental Accounts (NAMEA), developed in the Netherlands. NAMEA structures the conventional accounts in matrix form and extends the matrix to identify pollutant emissions by sector. The physical data in the NAMEA format are used to assess the impact of different growth strategies on pollution and environmental quality.

- **Disaggregation of conventional national accounts.** Among the items which are identified in this module of the SEEA are expenditures on environmental protection, production and trade of environmental protection products, capital formation for environmental protection, and environmental charges and subsidies. The disaggregation of such data provides more detail than is in the conventional accounts without changing any of the totals. These data are used to observe links between changes environmental policy or environmental quality and costs incurred by industry, government and households. They also highlight the development of new industries producing environmental protection equipment.

- **Value of non-marketed environmental services.** These include such uses of the environment as water filtration, waste absorption, recreation services, etc. This is a relatively controversial module, as some analysts believe that it moves too far from the structure of the conventional SNA to be included in an accounting activity, and it should more properly be part of a modeling study. Others argue that if we leave out the value of services, we are including the costs of protecting the environment but not the benefits, and therefore prefer to see it in the accounts.

- **Environmentally adjusted GDP.** The SEEA calculates environmentally adjusted net domestic product as follows:

	conventional NDP
less	depletion of non-produced economic and environmental assets
less	the cost of environmental degradation
equals	environmentally adjusted NDP

While the inclusion of this item is not particularly controversial, most people working on accounting

minimize emphasis on "green GDP" or "sustainable GDP" because it is not clear what it means and it places undue emphasis on a single indicator rather than use of the underlying data for policy purposes. However such measures have clear appeal as a flag to draw attention to environmental issues.

The SEEA does not respond to all problems faced by countries in addressing the incorporation of the environment into their national accounts. In particular, it does not address global or transborder environmental problems such as pollution, biodiversity loss, and other international externalities. These might more properly be linked to the balance of payments accounts as unpaid negative flows to the rest of the world. Moreover, inherent in any national income accounting is that is does not necessarily involve the development or regional or local environmental data, nor does it link to efforts to build environmental considerations into corporate accounting.

APPLICATIONS

This paper has provided a brief explanation of why the field of environmental economics has emerged. It has explained how valuation, social cost-benefit analysis, and environmental accounting can help economic decision-makers understand how to integrate the value of environmental assets, goods, and services into economic decision-making. The papers which follow illustrate the application of some of these tools, using case studies from Pakistan and Bangladesh. The three cases all focus on valuing environmental goods and services. This is an appropriate starting point for the use of these tools, because it is a fundamental building block for both social cost-benefit analysis and environmental accounting.

The first case, by Samina Khalil of Pakistan's Applied Economics Research Institute, explores the many goods and services provided by the mangroves in the coastal area near Karachi. Mangroves are a rich and complex ecosystem, receiving attention from both biologists and environmental economists worldwide. This paper uses market prices as a proxy to estimate the economic value of two major products of the mangroves, fuelwood and fodder.

The second paper, by Md. Rumi Shammin of the North South University in Bangladesh, uses the travel cost method to estimate willingness to pay for the Dhaka Zoo. The zoo provides both recreation services to the visitors and wildlife conservation services to the world as a whole. Since it is more feasible to charge for recreation than for wildlife conservation, it is important to understand how much visitors might be willing to pay for the opportunity to visit the zoo. This paper also demonstrates that using the travel cost method is quite practical in a country like Bangladesh, so it may easily be applied to evaluate other assets as well.

The third paper, by Nasima Tanveer Chowdhury of the University of Dhaka, uses contingent valuation to estimate willingness to pay for publicly supplied drinking water in Dhaka's slums. Basic infrastructure to eliminate the health problems caused by urban pollution is one of the most pressing environmental needs in developing country cities throughout the world. However, the needed investments are often held up because revenues are expected to cover the costs. The application of contingent valuation to assess how much the beneficiaries of such projects would actually be willing to pay for them is an important step forward.

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