So far, we discussed environmental economics and the various tools such as environmental taxes and environmental accounts to measure the value of the environment. Let us now see relation between Economics and Environmental management.

Economic Perspective of Environmental Management

In order to learn natural and environmental resource analysis and management it is essential to be familiar with economic aspects of environmental issues. Factors that influence both factors are briefly given below

- Public participation in 'Free' markets will control excessive pollution and overuse environmental services.
- The clean environment requires the balance of marginal benefits and costs.
- Proper design of policy instruments to achieve the environmental goals.
- Valuation of non market goods is an essential economic perspective influencing environmental management.

We will next explain environmental valuation that helps us determine the economic importance of various impacts.

ENVIRONMENTAL VALUATION

The environmental problems the developing countries face are considerably different from those occurring in industrialised economies. For example, many rural populations in the developing economies depend on the direct exploitation of natural resources for agriculture, livestock raring, fishing, basic materials and fuel, both to meet their subsistence requirements and to sell in markets for cash income. Rapid land-use change has meant that many natural environments and habitats are disappearing quickly with the result that critical ecological resources and functions are being disrupted or lost.

The environment in developing countries is, therefore, very much related to health and welfare of rural and urban households. And, the basic production and consumption decisions of these households have a considerable impact on natural resources and environmental services. The lack of basic water supply, sanitation and other infrastructure services suggests that households highly value increased public provision of resource-based services. As a result, there has been a significant growth in the application of

household production function (HPF) and production function (PF) approaches for valuing non-market environmental goods and services in developing countries. They have now recognised the importance of the environment to human welfare and economic livelihoods.

Categorising environmental values

In the developing countries, on an average, agriculture accounts for 40% of the GDP and nearly 80% of the labour force is engaged in agricultural or resource-based activities (World Bank, 1998). It is estimated that by 2020, the rural population of the developing world will have increased to around 3 billion and the urban population will double from 1.7 to 3.4 billion (Pistrup-Andersen, et al., 1999).

Meeting the food needs of a growing and urbanising population with rising incomes will, in turn, put greater pressure on the agricultural resources of developing countries. Although food production is rising, the recent slowing in the growth in cereal yields has increased the demand for new land. Much of this land conversion will come at the expense of forests and other natural habitats. Annual tropical deforestation is 0.8%. Put differently, 15.4 million hectares are lost each year (FAO, 1993). However, land degradation is a severe problem in developing countries. Around 20% to 25% of vegetated land in these countries suffers from some form of human-induced soil degradation (Oldeman, et al., 1990).

Given these interlinking problems of population and environmental degradation coupled with the problem of poverty, there is a considerable interest among decision-makers in the developing countries in integrating environmental and economic policy concerns. As a result, there has also been an increased interest in

the application of environmental valuation techniques. Valuation in developing countries has proven especially important in three areas: accounting for the cost of environmental degradation and damage; analysis of market and policy failures that contribute to environmental losses and public investment decisions with resource impacts (Barbier, 1994).

Economic values are classified either by type of value or measurement approach, and both are useful for categorising environmental values in developing countries. We will touch upon both these classifications, next.

Types of economic values

One pertinent feature of many tropical ecosystems and habitats (e.g., coastal and marine systems, rainforests, watersheds, range lands and floodplain wetlands) is that they exhibit multiple benefits or values. To inform the policies, these values are to be properly assessed. A framework for distinguishing and grouping these values is, therefore, necessary.

The concept of *total economic value* (TEV) is one such framework. TEV distinguishes between *use values* and *non-use values*, the latter referring to those current or future (potential) values associated with an environmental resource, which rely merely on its continued existence and are unrelated to use (Smith, 1987). Typically, use values involve some human interaction with the resource whereas non-use values do not. Table 10.1 gives an example of the TEV framework, as applied to a typical tropical coastal and marine system:

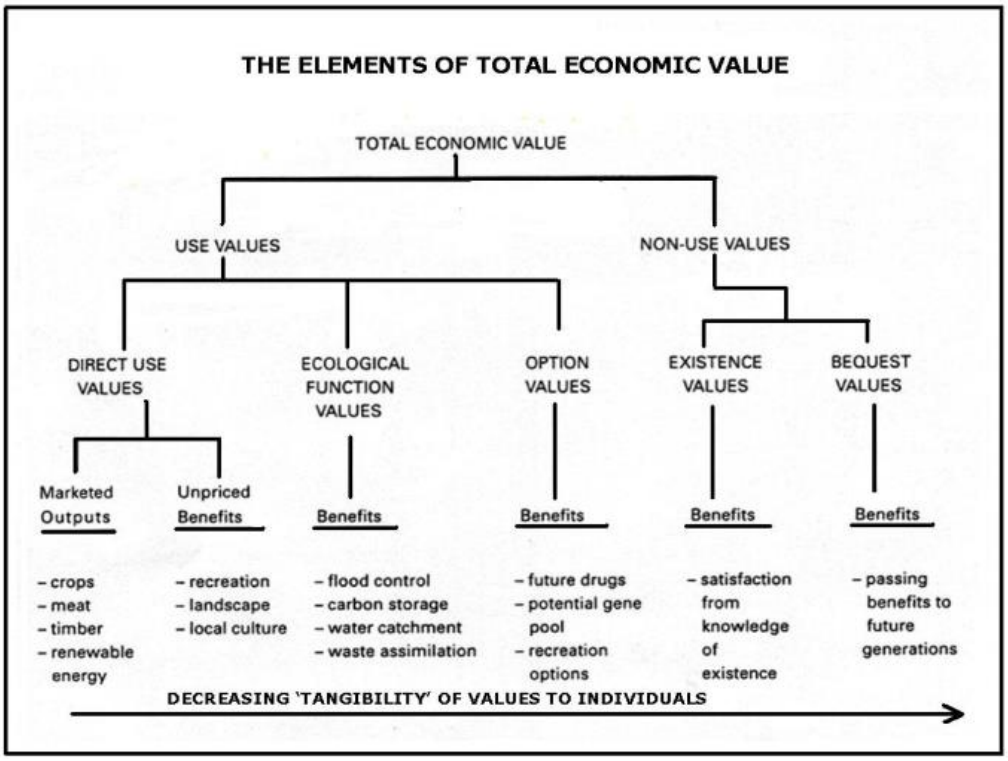
TEV Framework: A Sample

	Use values		**Non-use values**
Direct use values	**Indirect use values**	**Option and quasi-option value**	**Existence value**
Fish Aquaculture Transport Wild resources Wood products Recreation Genetic material Scientific/educational	Nutrient retention/cycling Flood control Storm protection External ecosystem support Shoreline stabilisation	Potential future uses (as per direct and indirect uses) Future value of information	Biodiversity Culture, heritage Bequest values

As Table 10.1 suggests, use values are generally grouped according to whether they are direct or indirect. Direct use values refer to both consumptive and non-consumptive uses that involve some form of direct physical interaction with the resources and services of the ecosystem (e.g., harvesting of fish and wild life resources, transport and use for recreation and tourism, etc.). Note that although tourism and recreation may be important in some areas, the most important uses of many coastal and marine systems in developing countries tend to involve both small-scale commercial and informal economic activity to support the livelihoods of local population, for example, through fishing, hunting, fuel wood extraction, and so forth. It is also increasingly being recognised that the livelihoods of populations in coastal and neighbouring areas may also be affected by certain key regulatory ecological functions. The values derived from these functions are considered to be activities that have direct measurable values (Barbier, 1994). The elements of economic values are given in figure 10.5.

Figure 10.5

Elements of Economic values



Economic measurement approaches

The measurement approach to the classification of economic values is usually determined by the following two criteria:

(i) If the valuation method is to be based on responses to hypothetical questions or on observed real world economic behaviour.

(ii) If the monetary values are to be inferred directly or through some indirect method of modelling individual behaviour and choice.

Table 10.2 illustrates the criteria for categorisation of economic values:

Criteria for Categorisation of Resources for Valuation

	Observed behaviour	Hypothetical
Direct	*Direct observed* Competitive market price Stimulated markets	*Direct hypothetical* Bidding games Willingness to pay questions
Indirect	*Indirect observed* Travel cost/time allocation models Hedonic models Averting behavior models Agricultural household models Random utility/discrete choice models Benefit transfer approaches Production function models	*Indirect hypothetical* Contingent referendum Contingent activity/behaviour Contingent ranking/rating

Source: Freeman, 1993

An important step in environmental assessment is the valuation of the impacts (where feasible and appropriate) in monetary terms to determine their relative economic importance, and assess the benefits and costs of various alternatives.

Valuation techniques

Valuation techniques involve measuring the physical impact, and then assigning a value to that impact. A number of valuation techniques are potentially applicable to each category of value. The specific choice of technique will, however, depend on the situation and on data availability.

The valuation techniques comprise the following:

- **Valuation of changes in outputs and direct-costs and of changes in output of marketable goods:** In many cases, the environmental effects of projects manifest themselves (at least in part) in changes in output of marketable goods. Loss of forest, for example, results in the loss of timber products, fuel

wood, fodder (whether collected or eaten on site by livestock grazed in the forest) and a variety of non-timber products such as fruit, herbs, and mushrooms. In cases such as these, the value of the unintended benefits and costs can be estimated by using the simple technique of valuing the change in output caused by the project. This approach is often referred to as the change-in-productivity approach.

- **Cost of illness and human capital:** Many environmental impacts such as air and water pollution have repercussions for human health. Valuing the cost of pollution-related morbidity (sickness) requires information on the underlying damage function (usually some form of a dose-response relationship) that relates the level of pollution (exposure) to the degree of health effect as well as information on how the project will affect the level of pollution.

  The cost of an increase in morbidity due to increased pollution levels can then be estimated using information on various costs associated with the increase in morbidity: any loss of earnings resulting from illness, medical costs such as for doctors, hospital visits or stays, medication and any other related out-of-pocket expenses. This approach is symmetric in that the benefits of actions that reduce the level of pollution and hence of morbidity are estimated in the same way. When this approach is extended to estimate the costs associated with pollution-related mortality, it is referred to as the human-capital approach.

  The human capital approach is similar to the change-in-productivity approach in that it is based on a damage function relating pollution to productivity, except that in this case the loss in productivity of human beings is measured. The human-capital approach is an extension of the more standard human capital theory, which relates the demand for education to its potential payoff in terms of expected lifetime earnings.

Because it reduces the value of life to the present value of an individual's future income stream, the human-capital approach is extremely controversial when applied to mortality.

- **Cost-based approaches:** When the benefits of a given environmental impact cannot be estimated directly, information on costs can be used to produce valuable information. For example, an order of magnitude estimate of the potential costs (or savings) to society from a change in an environmental problem can be obtained by using the cost of reducing or avoiding the impact, or the cost of replacing the services provided by the environmental resource.

  The major underlying assumptions of these approaches are that the nature and extent of physical damage expected is predictable (there is an accurate damage function available) and that the costs to replace or restore damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that these costs can be used as a valid proxy for the cost of environmental damage. That is, the replacement or restoration costs are assumed not to exceed the economic value of the asset. It simply may cost more to replace or restore an asset than it was worth in the first place. For example, cultivated hillsides may be eroding and there may be methods available (e.g., terracing, changes in cropping patterns) to reduce or prevent the erosion.

  However, each of these preventive measures has a cost, and it is the responsibility of the analyst to determine if the total costs of prevention are greater or less than the benefits of preventing erosion. In some cases, the costs of erosion control may be so high (and/or the benefits from controlling erosion may be so low) that erosion control measures will be an inappropriate use of scarce resources. In some other cases, there may also be more cost-effective ways to compensate for environmental damage than to replace the original asset or

restore it to its original condition, and these substitution possibilities are ignored with the use of this technique.

If substitutes are available, the method will be likely to overestimate the value of the damaged or destroyed asset. Because of this, these methods are generally thought to provide an upper-bound estimate of the benefits of measures taken to prevent the damage from occurring.

- **Replacement cost:** The replacement cost approach is often used as an estimate of the cost of pollution. This approach focuses on potential damage costs as measured by ex-ante engineering or accounting estimates of the costs of replacement or restoration if damage from pollution were to occur. For example, the costs of air pollution-related acid deposition in urban areas could be approximated by the restoration and replacement costs from damaged infrastructure.

  The replacement cost technique is particularly useful to assess the costs associated with damage to tangible assets, the repair and replacement costs, which are easily measurable. This information can then be used to decide if it is more efficient to allow the damage to occur and pay the replacement costs or to invest in preventing the pollution in the first place. The technique is less useful, however, for very unique assets such as historical or cultural sites and unique natural areas, which can neither be replaced nor easily be restored, and about which restoration costs are uncertain.

- **Relocation cost:** Similar to the replacement cost approach, the relocation cost approach uses estimated costs of a forced relocation of a natural or physical asset due to environmental damage.

- **Opportunity cost:** In some cases, it is decided to protect a particular resource and forego other development options. The

term opportunity cost refers to the value of these lost economic opportunities due to environmental protection. It is, therefore, a measure of the cost of environmental protection in terms of development benefits foregone. The Global Environment Facility (GEF) and other donors may be willing to provide grant funds to cover these types of costs, especially when the benefits produced are important at the global level.

Valuing environmental amenities

Often, the environmental good or service being valued is not traded *per se* in the marketplace. Examples of these amenity-type services include recreational sites and the preservation of biodiversity. A number of valuation techniques exist that can be used to place monetary values on these resources and this information, in turn, can be incorporated into a more conventional benefit-cost analysis.

A number of tools can be used for valuing environmental amenities. We will touch upon some of them, next.

Hedonic analysis

We know that environmental quality affects the price people are willing to pay for certain goods or services. Ocean/lake front hotels, for example, charge different rates depending on the view (e.g., rooms with ocean views cost more than the same size room with a garden view). Hedonic models have been widely used to examine the contribution of different attributes to prices for housing and to wage levels, including the contribution of environmental quality.

Many observed prices for goods are prices for bundles of attributes. For example, property values depend on the physical attributes of the dwelling (such as number and size of rooms,

amenities such as plumbing, condition, etc.); on the convenience of access to employment, shopping and education and on a number of less tangible factors such as environmental quality. Since each house will differ slightly from others, the influence of the various factors on its price can be broken down statistically, provided sufficient observations are available. This approach is of interest because many environmental dimensions are likely to be embodied in property values. A home in a neighbourhood with low air pollution, for example, should sell for more than that in a neighbourhood with high ambient air pollution. Hedonic techniques allow this effect to be measured, holding other factors such as size and amenities constant.

In essence, the technique estimates the implicit prices for various attributes, which together make up the sale price. Hedonic methods require observations of the prices of goods and of the attributes of these goods. To enable the effect of the many different factors to be distinguished, large data sets are usually needed. Because of their data intensity and the need for open reporting of prices, the application of these techniques has had limited (but often successful) application in developing countries.

Travel cost

Travel cost (TC) is an example of a technique that attempts to deduce value from observed behaviour. The TC technique was designed for and has been used extensively to value the benefits of recreation. It uses information on visitors' total expenditure to visit a site to derive their demand curve, i.e., the total benefits of the site's services. This technique assumes that changes in total travel costs are equivalent to changes in admission fees, and the demand curve is calculated, accordingly.

Note that the TC technique depends on numerous assumptions, many of which may not be tenable in the context of international tourism. For example, it generally assumes that travel cost is proportional to distance from the site and that people living at the same distance from the site have identical preferences. While these assumptions may be often valid in the case of national tourism, they may not be valid in the case of international tourism. This technique assumes a single-purpose trip and encounters difficulties, when trips have multiple purposes. It should also be borne in mind that the resulting estimates are site-specific. The main application of the TC technique in developing countries is valuing tourists' willingness to pay for national parks.

Contingent valuation

Unlike the techniques that use observed data, the contingent valuation (CV) technique relies on direct questioning of consumers (actual or potential) to determine their willingness to pay (WTP) to obtain environmental goods. In principle, this technique can be used to value any environmental benefit. Moreover, since it is not limited to deducing preferences from available data, the technique can get information about the specific benefits of a proposed project. This also means that, with appropriately worded questions, the CV technique can provide an all-encompassing estimate of the perceived costs and benefits of environmental changes, in contrast to other techniques which, as noted above, often only provide a partial estimate of environmental costs and benefits.

ECONOMICS OF NATURAL RESOURCES

It is a rare day when the newspaper does not cover a topic relating to natural resources or the environment. The topics may be the supply of electricity and water to households, farms and businesses; shortages and high prices of petrol or diesel; debates about land use decisions; disputes between states over water rights; pollution from industries and vehicles, etc.

The bulk of the news about natural resources, concern conflict over alternative ways to use them because the resources are scarce to serve everyone's wishes. Conflicts inevitably emerge when different people wish to use the same resource in different ways. For example, when a factory wishes to dispose pollutants into water used by villagers for drinking water, the central problem is that there is not enough to meet both parties' needs.

By definition, scarcity means that there is not enough to satisfy everyone's demand. This, in turn, means deciding not only who has rights over them but also how these decisions should be made. Economic analysis can identify productive patterns of natural resources use. It can assess the economic incentives that guide people towards or away from such patterns. It can also evaluate the implications of these patterns for equity and sustainability. This, in fact, is an essential tool for designing policy and management strategies.

Against this backdrop, we will discuss the economics of natural resources with particular reference to fisheries, forestry, water and agriculture.