SOME GUIDELINES FOR EVALUATING THE ENVIRONMENTAL IMPACTS OF FORESTRY PROJECTS

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INTRODUCTION

The correct method of valuing public sector projects has proven contentious (Zerbe and Dively, 1994) with disagreements over the principle of discounting as well as the more practical aspect of which rate of interest best approximates the social discount rate (Lumby and Saville, 1995). This has been of particular concern to forest economists, many of whom believe that complexities and omissions in the evaluation of public sector projects have led to a comparative under-investment in forestry projects, or perhaps a lack of conservation thereof. Their response has been two - pronged. First, they have recognized the low return of forestry projects when returns are calculated using a conventional discounting method, but have argued for a special status or treatment for forestry projects. In particular, they have argued for the use of a lower discount rate for the appraisal of forestry projects on the grounds that they have special characteristics; namely, a long gestation period; joint production of timber, non-timber, and environmental products; risk, and the strategic role of forests in the economy among others. However, the major flaw with this argument is that the low rate of return is computed without including environmental impacts/benefits emanating from forests[1]. This has led to the second response by environmentalists, and that is to challenge the logic of the low discount rate by including the intangible or environmental impacts, whilst computing the rate of return (Nautiyal and Rezende 1983) [2]. This would permit the full valuation of goods and services produced by forests; and, hence would promote investment in the forestry sector and sustainable forest management practices, as reflected in the Forest Principles of Agenda 21, Rio Summit, 1991. The full valuation results can also be used in determining or influencing pricing, land use and incentive policies (Munasinghe, 1993); it can provide a rational basis for determining the transfer payments from developed to developing countries (CSERGE, 1993)[3]. The full valuation approach would also provide sound decisions on the promotion of monoculture plantation forests, for they produce negative environmental effects, unlike the natural forests. Furthermore, the more accurate evaluation of intangible outputs of forestry projects would strengthen the multiple-use-management of forest resources.

However, the major problem with the full valuation approach is the lack of hard data on intangible environmental impacts emanating from forest. Both the price and quantity of intangibles are difficult to estimate because no product markets exist and hence no price tags are available. This is in contradistinction to the estimation of tangible benefits (timber and non-timber outputs), as their quantities and prices are relatively easy to ascertain. In the past, most of the research on valuation of forestry intangibles is done in the developed countries, and very little in the context of developing countries which are characterized by indifference towards the issue for various reasons[4]. A voluminous amount of literature on the valuation of environment has appeared in the economic journals during the late 1980s and the1990s, but with less focus on the valuation of environmental impacts of forestry projects (Dixon et al, 1994; Freeman, 1993; Gregersen, et al., 1990; Hufschmidt et al 1983; Pearce and Markandya, 1989). More recently, having realized the importance of ascertaining cost/benefit estimates of intangible outputs of forestry projects, the Food and Agriculture Organization (FAO) has developed some field manuals which provide some guidelines for appraisal of forestry projects[5]. This paper fits into the second category in that it attempts to draw together and systematize the various methods which at one time or another have been put forward by economists in an attempt to account for the often ignored intangible benefits of forests. To this end, the conceptual model for valuation of intangibles is introduced in the second section; the problems in applying the model to forestry projects are visited in section three. The fourth section deals specifically with the valuation of various specific environmental impacts of forestry sector in general (forestry intangibles). The conclusions and possible areas of future research are identified in the last section.

A REVIEW OF THE BASIC VALUE MODEL

The Model

The fact that the valuation of intangibles is fraught with difficulties does not obviate the fact that society still has to balance its choices between producing and preserving the environmental benefits of forestry projects, or cutting the forests down for agricultural and/or industrial development. The choice depends upon the value society places on the environmental by-products emanating from forests over other alternative uses of land. Or, in other words, society's choice depends upon the net utility that it derives by consuming or investing in environment-augmenting industries such as the forestry sector of a nation (Sinden and Worrel, 1979). In notational characters the value of environmental commodities (V) is equal to the utility (U) gained from their consumption minus the disutility (DU) in obtaining the same; or,
V = U - DU. This is the fundamental value equation of neoclassical economics. Because value in economics implies the power of exchange that a commodity commands, which in turn depends upon the demand for and supply of that commodity. This follows that value of intangibles can also be estimated from the demand-supply framework or from the basic model of exchange[6].

To begin with, we assume that demand (marginal benefits) and supply (marginal costs) schedules for intangibles are given as shown in Figure 1. The negatively sloped marginal benefits or demand schedule implies that as the price of intangible environmental commodities is lowered the quantity demanded will increase. Similarly, positively sloped supply schedule suggests increasing additional cost for each additional unit of intangibles produced. The intersection of the supply and demand schedules determines the equilibrium price P and quantity Q of intangibles (Figure 1).

(Insert Figure 1 around here)

The total utility received by the society, and the consumers in particular, by consuming Q amount of intangibles, is equal to area (a+b+c); the costs to the society are represented by area (c). Hence, the area (a+b) is the net gain to society and is defined as net social benefits or payoff. Of the net social benefits, areas (a) and (b) represent consumers' and producers' surpluses, respectively.

The Methods

The model referred above represents the standard value model, which should be ideally used for the estimation of intangible benefits. For example, technological and managerial advances, which lower costs and therefore shift supply curves outwards and to the right, are in a sense intangibles, and net benefits from them can be estimated by comparing the consumer and producer surpluses before and after the change. In this case, the entire relevant area (a+b) or the net social payoff can be measured; however, this requires the estimation of both demand and supply schedules before and after the change. Grilliches (1958) used this approach to estimate the value of research on hybrid corn. Similarly, Hammack and Brown (1974) estimated the net benefits resulting from an improvement in the management of duck-habitation in North America.

However, in many situations it is difficult to apply the full value model as the demand and supply schedules cannot always be estimated exactly. Other methods used in the past have often only partially implemented the value model. For example, these methods include contingent valuation, opportunity cost, travel cost, hedonic pricing, among others. The **contingent valuation method (CVM)** tends to estimate area (a+b+c) as a measure of **willingness to pay** for the intangibles[7] [8]. The CVM elicits, through surveys, how people would respond to hypothetical changes in some environmental resource (Hanemann, 1994; Desvousges et al., 1987). For example, Barret and Waddel (1973) used this approach to estimate the value of clean air, whilst others have used it to estimate the value of natural wonders, such as the Grand Canyon (Schulze, et al., 1983); aesthetic changes due to coal-electricity plant (Randall et al., 1974) ; congestion effects in wilderness recreation (Chicchetti and Smith, 1973); and, water quality improvements (Desvousges et. al. , 1987). Two major problems that are encountered with this approach are that the results of survey may not be representative; and , that the responses may be affected by an individual's beliefs (Bishop and Cicchetti, 1975; Diamond and Hausman, 1994) [9].

Among other methods of valuing intangibles, **opportunity cost** can be used as a proxy for measuring benefits. The rationale of opportunity cost methods rests on the belief that in a perfectly competitive economy prices are a function of consumers' willingness to pay and suppliers' willingness to produce, and that willingness to produce depends upon the opportunity costs of resources. Thus benefits are assumed to be at least equal to the costs incurred or area (c) in the value model. Here, both the consumer's and producer's surpluses are ignored. However, some other opportunity cost methods attempt to measure area (b+c) in the basic exchange model as an opportunity cost of resources. A variety of opportunity cost methods have been devised with some modification between approaches. For example, the **preventive expenditures** (PE) incurred to prevent the degradation of the resource or **replacement cost** (RC) incurred to restore the original state of resource can be used as a proxy for environmental benefits (Winpenny, 1991)[10]. For example, benefits from flood and fire protection can be equated to replacement costs or damages that are avoided (Pearce and Moran, 1994). Or the psychic costs of the loss of family and friends through migration can be accounted for by including costs of the future visits that will be needed to maintain contacts (Schwartz, 1973). Likewise, savings in social costs resulting from new environment-augmenting technology, such as water pollution control, can be treated as net benefits of the environment. Sometimes intangibles such as convenience can be valued in terms of time-cost. For example, Foster and Beesely (1963) estimated the value of convenience of a seat on computer train, in comparison to the inconvenience of standing and holding a strap, in terms of times. Some opportunity cost methods emphasize on measuring the consumers' expenditure, area (b+c), as a proxy for benefits from consumption of intangibles and in this case area (a) or consumer surplus is ignored. For example, Burton and Wibberly (1965) equated the benefits of recreation with consumer’s expenditures.

The other popular method used for valuing environment is the **travel cost** approach; it is commonly used for valuation of outdoor recreation. The method was initially proposed by Hotelling (1947) and operationalized by Clawson (1959), and Clawson and Knetsch (1966); however, since then many refinements have been made. The method measures the consumer's surplus from outdoor recreation with a restricted assumption that the consumer surplus obtained by the marginal user is nil. Because the supply curve of visits is assumed to be perfectly elastic, producer surplus in this case is also nil. The basic recreation demand function is specified as $Q = f(P, X_1 \ldots X_n)$; where Q is the quantity of visits taken per unit of time, P is the price of a visit, X_1 to X_n are income and other explanatory variables. Since P is not directly observable, several other proxies can be used; including travel-cost, travel-cost plus entry fee, distance (Clawson, 1959; Clawson and Knetsch, 1966; Mesewitz, 1966; Mansfield, 1965; Cesario and Knetsch ,1970; Cicchetti, Fisher, and Smith 1973; Freeman, 1979; McConnel and Strand, 1981; and Smith 1989). The travel cost method has been used to estimate the benefits from recreation and tourism. Sometimes an **inverse travel cost** demand function is preferred; that is, the price or travel cost is specified as a function of the site characteristics, income and other variables (Smith and Yoshiaki, 1987; Brown and Mendelshon, 1984). This is also known as **hedonic travel cost** (HTC) model. Of course, the travel cost approach has its own limitations. One major limitation is that it does not consider the cost of foregone leisure time. This is because the greater the travel distance the less attractive a site becomes, thus leading to the loss of leisure time. Although there are various measures suggested to take into account the loss of leisure time, such as shadow prices of leisure, wage rate, and other (Cesario, 1976), the disagreements among experts still remain as to how one should evaluate leisure time[11]. Randall (1994) has proposed the **travel price method** (TPM) as an alternative to TCM to overcome several shortcomings of it.

The other method for estimating environmental benefits rests on measuring the indirect effects of environment on surrogate market goods such as property and labor. For example, afforestation of hill stations can increase the number of tourist visits and therefore the values of land or surrounding properties. Similarly air and water pollution have indirect effects upon the values of real estate (Ridker and Henning, 1967; Anderson and Crooker, 1971; Rosen, 1974; Smith, 1983; Bartik and Smith, 1989; Michaels and Smith, 1990; Smith and Huang, 1993). If all major explanatory variables can be statistically controlled, the residual variable can be taken as a proxy for an environmental attribute. Likewise, wage differentials can be explained in terms of age, skills, education, location, and environmental risk (Hoch, 1974; Roback, 1982). This is called the **hedonic price function**. The hedonic price function describes the relationship between the equilibrium price of commodity and its characteristics including environmental attributes. In this case, land or real estate values can be regressed on appropriate indices of environmental variables (such as air quality) along with other usual variables. In this way; hedonic prices, which represent the marginal willingness to pay for the environment, can be estimated directly or indirectly, with some manipulation of estimated regression-coefficients, depending upon the utility function assumed (Pearce and Nash, 1981, pp.136-139)[12]. A special case of hedonic price estimation is the land-price method in which land values are regressed on appropriate indices of intangibles as explanatory variables. The land-price method has been used to estimate: the values of trees (Payne et. al. , 1973); the aesthetic value of forests (Armstrong, 1974); the value of clean air (Waddel 1974); social benefits from wet lands preservation (Gupta and Foster, 1975); effects of congestion on the wilderness value (Cicchetti and Smith, 1973). The major problem with hedonic pricing is that it provides a partial measure of net social benefits. For example, improvements in air quality not only increase land prices but also improve health. The land price method thus ignores the latter benefits. In addition there are statistical complexities involved with the method (Freeman, 1979; Pearce and Markandya, 1989); and sometimes the necessary assumptions are too restrictive to be meaningful (Winpenny ,1991).

APPLYING THE VALUE MODEL TO FORESTRY PROJECTS

The basic exchange model as described above is a static model, involving only one-period demand and supply schedules. However, forestry projects generate a time series of tangible and intangible benefits, which are jointly produced. Similarly there are costs incurred over the years in planting, maintaining, regenerating and harvesting these products. The value model described above should therefore be dynamized. In a nutshell, we need the demand and supply schedules of forestry intangibles for each year of the economic life of a forest.

There are two major conceptual problems in dynamizing the value model. The first problem is that it requires knowledge of marginal benefits and marginal costs of each forestry intangibles for each year. There are serious conceptual problems in obtaining these values, in addition to many practical ones. The problem of determining marginal benefits lies in the fact that most of the intangible environmental products are produced jointly with tangible products and has the nature of public goods and externalities. Also, due to the joint production process the apportioning of costs between two products of different nature (market and non-market) is difficult because of the interdependence of cost and production functions. For example, the average and marginal cost of producing timber/market goods cannot be separated from the cost of producing flood control and soil conservation benefit, irrespective of whether products are produced in fixed or variable proportions (Heady, 1952; Duerr, 1960). Conceptual problem arises in how to allocate the fixed costs between timber and environmental outputs of forests products. The allocation of fixed costs according to the contribution of each product in total revenue cannot be applied because the contribution of timber products alone is known. The problem of estimating marginal benefits/costs is further complicated because of lack of knowledge about relationships between the two products. The two products—the timber and environmental impacts—can be produced in a fixed or variable proportion. If a fixed proportion is assumed, then the amount of non-market products can be determined from the amount of market or timber products. However, many examples in forestry seem to support the latter relation. For example, fast growing species like Eucalyptus and Poplar maximize timber production but not soil and water conservation, while some slow-growing species maximize soil conservation at the expense of timber production. Furthermore, the knowledge about the production function of forestry is also limited (Duerr, 1960); a sound production function is not known even for timber. Hence, estimating a relationship between timber and environmental products is an uphill task that we have to come to terms with. Without the knowledge of production and cost functions of forestry, one cannot determine the value of output and therefore cannot place a value on benefits and costs.

The second problem is associated with finding an appropriate procedure to aggregate marginal benefits and costs, even if the schedules can be estimated for each year. This is because a benefit (cost) received (incurred) now is worth more than that received later. Fortunately, this can be overcome via discounting, in which future values are discounted to the present, using an appropriate discount rate. The choice of discount rate depends upon time preference, which would be different for a society than it would be for an individual or a group of private firms. For public projects, such as forestry, a social discount rate, which shows society's time preference, should be used [13].

This means that if multi-period demand and supply schedules for environmental impacts can be estimated, then net social benefits resulting from environmental impacts can be aggregated through a discounting procedure. However, the estimation of marginal benefits from different forestry benefit streams, for each year of the economic life of forests, is a difficult task as future prices are not known. This problem can be overcome if one assumes constant prices on the grounds that forestry projects are not generally large enough to alter general price levels[14]. It means that simple costs and benefits based on fixed prices can be computed and can be used to estimate the value of environmental benefits, eliminating the need for estimating the annual demand and supply schedules for environmental outputs of forestry projects. Thus, timber (or private) and environmental or (public benefits) emanating from forests can be assigned values each year. Similarly, on the cost side, the cost of resources can be assigned value; however, in this case the costs are the same for both tangible and intangible outputs and we need not allocate costs to them differently. That is, unlike private and public benefits, private and public (social) costs are one and the same as there are arguably no negative externalities from forestry projects[15]. Thus **social benefit-cost analysis (SBCA)** can be applied to the evaluation of environmental impacts of forestry projects.

METHODS OF VALUING FORESTRY INTANGIBLES FOR SBCA

At this point one reaches the heart of the problem: that is, the environmental outputs from forests appear as public goods or public good externalities for which there are no markets. Absence of markets makes the SBCA more difficult to apply than the situation when market prices are available even though these occasionally need to be corrected if they are not producing socially optimum quantities of products due to market imperfections. This is, in fact, the major problem in applying SBCA to forestry projects (Nautiyal and Rezende, 1983). In an attempt to overcome these problems, different approaches have been used to value the environmental benefits. In this regard, the method of valuation mostly depends upon the characteristics of the environmental products in question, hence the method of valuation becomes specific to the nature of environmental impacts generated by the forestry projects. Various environmental outputs of a typical forests can be broadly classified into seven categories:

- Flood Control Benefits
- Water Production
- Soil Conservation and Protection of Land Productivity
- Outdoor Recreation
- Biodiversity and Conservation
- Aesthetics and Habitat
- Carbon Storage or Air Purification

Flood Control Benefits

Flood control benefits from forests arise because of the role of forests as stream regulator. That is, forests help increase the seepage of rainwater and thus reduce the overflowing and speeding of water streams, which generally causes flood damages. Forest cover can only reduce flood damages but not eliminate them (Storey et al, 1964). The role of stream regulator is very important, particularly in the tropical countries where 60 to 80% of the mean annual rainfall is received during a short period of 3 to 4 months. In other countries this regulatory role may not be as important if grassland performs the same function. Flood control benefits are pure public goods (Samuelson, 1954; Abouchar, 1977; Layard and Walters, 1978; Varian, 1978). They are enjoyed not only by the people living in the surrounding areas but also by those who are situated far away. Generally, flood control benefits are valued as equal to the difference between damages resulting with and without the flood protection services of forests. However, practical problems arise in estimating flood damages. For example, flood damages in river basins can vary with the different percentages of forest cover and tree species. Obtaining empirical data for this is a tedious task. Another suggested approach is to use flood insurance premium as a proxy for benefits. However, costs are difficult to allocate because of the joint nature of production and lack of knowledge about the production relationship between intangible and tangible forest outputs. In addition, the estimation of costs of intangible costs (psychic costs) of flood damages is a real problem and these are generally ignored (James and Lee, 1971).

A naive but practical approach to value food control services of forest is to develop a flood protection index (FPI) which can be translated into monetary values (Rezende, 1978). For example, a FPI of 0.0 can be assigned to the land with no forest cover and this index value increases with the age of forests so as to reach the maximum possible figure of 1.00 in the case of a 30 year or older stand. The monetary value can be calibrated and set equal to the value of damages or protection of private goods, crops, livestock, other assets, human life, and so on. The other approach to value flood control benefits is to estimate the size of population subjected to flood risk and hence the lost incomes over the years depending upon the frequency of floods in a specific location. Ruitenbeek (1989) used this approach in the case of the Korup forest project in Cameroon.

Water Production

Another environmental benefit arising from afforestation is the water production. Forests help produce water in two ways: (1) by increasing the seepage of rainwater, which, through subsurface flows, eventually reaches the streams; and (2) by inducing precipitation. In a deforested area water reaches streams immediately after rainfall in the form of run-off. Afforestation increases seepage and thus streams do not overflow. Rather, through subsurface flows, water reaches the streams with a time lag. Thus, water is more equitably distributed over the year. In addition, the quality of this water is better because it is filtered through the earth surface. Benefits thus arise not only in terms of quantity reaching the stream but also in terms of its quality and timings. The type of tree species and the age of the forest may also affect quality and timings. For example, an Oak tree stand is expected to produce a better quality of water than a Pine stand. The timing and quality of water are thus very valuable to human health.

How does one assign value to this water produced by the forests? The value of water may be different for different uses. One direct approach is to use the cost of producing water by any alternative means, i.e., the replacement cost. For example rainwater can be collected and purified by artificial techniques on surface tanks and then distributed throughout the year. Another approach would be to estimate the value of the loss of human health due to unavailability of this water produced by forests. All this requires large data, which generally do not exist, especially in the developing countries.

Generally it is argued, and accepted, that forests induce precipitation (Zon, 1935; Marsh, 1965; Rasmussen and Went, 1965). Forests at most can increase the precipitation by 5% of the amount of rainfall in a region (Rezende, 1978, 71). In a region where precipitation is lacking, an increase in rainfall by 5% would be significant and should be taken into account for the SBCA. A practical way to value this extra rainfall is to estimate the correlation between annual precipitation (including distribution throughout the year) and the value of total production in the region. If correlation is insignificant, extra benefits/costs from the extra rainfall can be set equal to zero. And, if a significant correlation exists, say 1% increase in rainfall is associated with a certain magnitude of increase or decrease in production, then a rough estimate of the value of rainfall can be made. Sometimes, it is suggested that if 15% variation in the regional precipitation does not have any positive effect on the value of production then benefits of extra rainfall can be set equal to zero (Rezende, 1978). Most times, the extra rainfall generated by the forests is an intermediate public good whose value will be reflected in the value of the final private goods produced. Water production from forests affects both producers and consumers by entering into this production and utility functions, respectively. The value of water produced thus varies, Calish et al. (1978) used a price of US$15 per acre foot for water produced by a forest in Northwest United States, and quoted Dryland and Gordon saying that the value of water can be as high as $420 per acre foot.

Soil Conservation and Protection of Land Productivity

Although the magnitude of soil protection, which would otherwise be lost through soil erosion, depends upon several factors, the vegetative or forest cover is undoubtedly one of the most important factors. It is especially important if land gradients are very high. One should, however, note that soil losses resulting from the entropy law, or what is called geological erosion, is not to be included in the SBCA of forestry projects. It is the accelerated soil erosion loss that needs to be protected or valued. Forests not only provide soil protection to the afforested lands but also increase the productivity of such lands. One approach is to estimate the soil protection value of forest lands over and above the second best use of soil, say, for example grassland (Rezende, 1978). Or the service of forests in maintaining or recovering the productivity of soils would be reflected in the prices of the final private goods produced including the land value. Hence, a hedonic price function including soil protection as an explicit argument can be estimated to reflect the value of soil conservation provided by forests.

The other approach is to resort to the **universal soil loss equation (USLE)** to estimate soil loss and its effects on the land productivity which can, in turn, be given some monetary value. For example, Bishop and Allen(1989) used this approach to value the on-site cost of soil erosion in Mali; and, Wiggins and Palma (1980) used it to estimate the crop yield losses from soil erosion and benefits from avoiding losses in power generation due to silting of the reservoir in El Salvador. A modified USLE was used by Brooks et al (1982) for valuing the benefits of afforestation on upper slopes in Loukkos basin in Morocco.

Outdoor Recreation

Forest produces recreation benefits such as camping and holiday cabins, leisure walking, picnics etc. The outdoor recreational value of forests is well evaluated in the literature, primarily using the travel-cost approach. Travel-cost estimates the outdoor recreation value of forests by attempting to measure the demand for recreation based on travel cost expenditures which are used as surrogate market to proxy recreation value. The CSERG (1993) used this approach to estimate the value of Mexican forests in generating ecotourism. The United Kingdom Forestry Commission funded a nation wide travel cost method studying of forestry recreation values in Great Britain (Benson and Willis, 1990).The estimates of UK forest recreation values evaluated with travel-cost method, range between pound 1 and 428 per hectare, with an average of £47 per hectare. The total annual recreation value of Forestry Commission estate was estimated to be £53 million at 1990 prices, (Bateman,1991, p.157).

Biodiversity and Conservation

Putting a value on the biodiversity and conservation aspects of the forests is a difficult task. The value can be assigned to the diversity of both fauna and flora. In the case of fauna, valuing the diversity of wildlife is the most important one. The total value (V_w) of wildlife or animals is composed of preserved (V_p) and games value (V_g). As numbers of an animals specie diminish, both preservation and game-values are expected to increase. But, after reaching a certain number of animals, the preservation becomes more important than game or the commercial use of animal, and preservation becomes strategic. It is perhaps easier to put a value upon a game or commercial aspect of an animal or plant species because it is reflected in its price. For example, the commercial value of wildlife is reflected in the price charged for each hunted animal (the license fee). But, wildlife diversity being a public and final good poses problems of putting a value on it. Generally, wildlife diversity or protection value is associated with the type of forest management system--Intensive and extensive (Bunnel, 1976). Under intensive management, timber output of forest and wildlife diversity behave as competitive outputs while under the extensive management they contribute to each other or behave as complementary outputs. For the purpose of the SBCA, the value of wildlife protection and diversity can be set equal to zero for the pure tropical plantations where the rotation is short. Or, in circumstances where large numbers of animals are not in danger of extinction and interfering with timber production their value may be negative. Boyle and Bishop (1987) discuss in detail different types of values that are relevant in the valuation of the wildlife. One can perhaps use the same logic for the exploitation and conservation of plants or flora.

In valuing species preservation, one may wonder whether to value individual species or a stock of a number of species or biodiversity. Valuing biodiversity is equally important and CVM is found to be very useful tool here too. For example, Pearce and Moran (1994) advocate contingent valuation technique to put value on the biodiversity. This implies the creation of fictitious markets (demand function for biodiversity). For example, Kramer and Mercer (1997) used the CVM to estimate the U. S. residents' willingness to pay to protect tropical rain forests; this was estimated to be US$ 1.9 billion. Bowker and Stoll (1988) used the dichotomous choice form of contingent valuation to quantify individuals economic surpluses associated with the preservation of whooping crane in North America. Loomis and white (1996) used the contingent valuation to measure the value of endangered fish species in USA and recommend highly of CVM for valuation of fisheries. Garrod and wills (1994) found CVM a useful tool in informing local-level management decisions; providing information on the use and the non-use values of forests accruing to members, value of new additional reserves of different habitat types, and the income generation potential for new conservation program. There are reservations also lined out against the CVM for valuation of biodivesity. For example, Hanley et. al. (1995) has reviewed the problems in valuing the benefits of biodiversity protection and limitations of the benefit-cost analysis, particularly when people have lexicographic orderings. They found that CVM works better if people have more and better information. However, Gowdy (1997) argues that CVM is incomplete and cannot capture the total value of resource (use plus and non-use). Some estimates of opportunity costs or existence values can also be made. The proxies for this could be the cash offer from an international conservation group, market value of flora and fauna should there be any use of them in local conditions, costs of replacement among others (Winpenny. 1991, p175). One of the criticisms of SBCA is that it is people-centered or anthropocentrism. This means the fate of every species depends exclusively upon its contribution to the well-being of people (Montgomery and Pollock, 1996). This makes the valuation of biodiversity a people-biased analysis.

Recreation from forest is a use value in the sense that individuals visit and thereby use the forest. But, even if individuals do not visit forest people still likely to value the presentation for future generation or other potential uses (option, existence, and bequest values, or non-use values). Benefits of species preservation or non-use values at times can be substantial and the CVM is the most popular technique used for this purpose. For example, Stevens et al (1991) found substantial economic benefits from protection and restoration programs for Atlantic salmon, bald eagles, and wild turkeys in New England, United States. Boyle and Bishop (1987) used the CVM to estimate the value of bald eagle in the United States. Walsh et al (1990) found that people in the USA were willing to pay for the preservation of the forests, almost 30% more to ensure that future generation could enjoy forest recreation (bequest value). In other worlds, over 50% of bids were to preserve the non-use values of forests. Almost, similar results were reported in the UK on a small sample study of six forests in England and Wales (Willis and Benson, 1988). The non-use value of UK forests is thus estimated to be between £9 and 54.5 million (Bateman, 1991, p. 159).

Aesthetics and Habitat

The aesthetic value of forests arises in terms of pleasure derived by individuals in contemplating a forest area. This pleasure depends upon the age of forests and other things such as hills, valleys that add beauty to the forests. The aesthetic value or appeal of forested area increases monotonically as trees grow to maturity (Calish et al, 1978). Other things such as hills, valleys, streams, open spaces also add to the aesthetic valued forests. It is therefore possible to overestimate the aesthetic benefits of forests if these things are ignored. Sometimes, the removal of some forest area might add to the aesthetic value particularly when it hides a scenic view. The aesthetic value of forests also depends upon the location of forests. In regions that are densely populated or that are of major tourist attraction, the aesthetic value of forests is expected to be much higher than sparsely populated areas.

The aesthetic or spiritual value of forests is difficult to estimate. Methods like CVM or TCM cannot capture the effects as people immediately affected are wholly or largely outside the money economy (Winpenny, 1991, p88). The local people and outsiders may have different perceptions about the benefits and costs of forestry. For example, urban populations may obtain more pleasure from the forests than the ones who are living in the jungle. Various proxies are suggested to estimate the existence values of these forests; for example, the amount of finance available for preserving forests by conservation groups can be one such proxy; the sale value of books and films about the forests and wildlife and tourism can be also regarded as other surrogates (Ruitenbeek, 1989). However, one can use the travel cost or contingent valuation methods when forests are in or close to urban centers as there is some appreciation of these benefits of forests. For example, the CVM and TCM were used to estimate the benefits of Lumpinee public park in Bangkok (Winpenny, 1991, 185p). Tobias and Mendelsohn (1991) used the TCM to value the ecotourism at the Monteverde Cloud Forest Biological Reserve in Costa Rica. This study concluded that Costa Rican citizens place a value of about $35 per visit and the domestic annual recreation value ranging between $98 and $116 thousands.

Forests can also be assigned existence and option values (Pearce, 1993; Bishop and Welsh, 1992). Brookshire et al (1983) estimated the option and existence values for wildlife resources with the CVM. Various studies have preferred the use of CVM for assessing habitat value of forests. For example, studies by Hagen et al (1991) and Rubin et al (1991) used contingent valuation surveys to estimate how much respondents would be willing to pay to reserve additional spotted owl habitat in USA;

however, the technique has its own limitations (McKillop, 1991). Clayton and Mendelsohn (1993) measured the visitors' willingness to pay to visit McNeil river, a bear watching site with help of CVM. Echeverria et al (1995) used CVM to estimate the non-market amenities provided by the Monteverde Cloud Forest Preserve in Cost Rica.

One important option value of forests is that it can be a source of pharmacologically active substances. It is often cited as a reason for promoting forest conservation/biodiversity. Many western medicine are derived from plant sources (Bell, 1993). The commercial value of drugs can be used as a proxy for benefits arising from habitat protection(Principe, 1990; Farmsworth and Soejarto 1985). Or, it can be computed with the help of the following equation (Pearce, 1993, p85):

$$VMP = p \cdot r \cdot a \cdot V_i(D)$$

Where,

VMP= the medicinal plant value of a hectare of biodiversity land;

p = probability that a biodiversity supported forests will yield a successful drug;

r = royalty rate that the host country can earn in the case of a successful drug being invented;

a = coefficient of rent capture;

V_I (D) = value of the drug where subscript $_i$ refers to the two ways of computing the value of drug (i=1, when market value of the drug is used) ; i = 2, when shadow value of the drug which is determined by the number of lives that the drug saves and value of a statistical life is used).

The value of p is between 1/1000 and 1/10000, depending upon the forests; the suggested value of r = 0.05; suggested value of a ranges between 0.1 and 1.0; the value of drug can vary substantially. Thus, the medicinal plant value of biodiversity supported forests ranged between $0.01 and $21/ha. The local values can also be computed with local prices and at times that can be higher than global value as was found by Balick and Mendelshon (1992).

Carbon Storage or Air Purification

Role of forests in the global carbon cycle is well documented and understood in the scientific circles. The carbon sequestration benefits of forests can be estimated in two steps. In step one, the carbon sequestration and storage is estimated with the help of physical models of forest types and land use change[16]. The second step is to place a monetary value on this function of forests in terms of global warming damage avoided. It is interesting to note that the carbon storage benefits accrue more to the global society than to the local people. In conducting the SBCA of forestry projects one should bear in mind that in whose point of view the analysis is to be conducted. If it is in the interest of local authority, the benefits from carbon storage can be excluded or treated as costs. However, if the SBCA is done from the view of global society the benefits from carbon storage should be included.

Carbon dioxide is the main gas responsible for greenhouse effect. Current global emissions are to the tune of 500 million tonnes of carbon dioxide per annum plus another 1500 million tonnes per annum from burning of tropical rainforest (Grayson, 1989). The carbon oxide emissions have now gone up 30 percent above the natural levels and may rise much above (Anderson, 1990). Tress absorb carbon dioxide during growth and release oxygen. Thus , they produce a social benefit by cooling green house effects. Numerous attempts have been made to put money value on the carbon fixing property of forests. For example, Wibe 1990) obtained the total money value by multiplying the annual carbon absorption rate by the proposed Swedish carbon tax rate of $0.15 per kg (politically determined rate). This is called the carbon tax approach[17].

Rule of Thumb

In circumstances where the above objective assessment of environmental impacts of forestry projects are not available, some forest economists have suggested a rule of thumb to assign at least as much value to environmental outputs of forests as to timber while the cost streams to remain the same (Nautiyal and Rezende, 1983). Tewari et al (1988) have used this approach for valuing the environmental impacts of community afforestation in the Western Himalayas. Though somewhat inexact this approach naturally has the effect of increasing the rate of return significantly, and should be used with caution.

SUMMARY AND CONCLUSIONS

In this paper an attempt is made to discuss various approaches to valuing the environmental impacts of forestry projects in the belief that the inclusion of intangibles in the valuation of forestry projects will correct the perceived under-investment in this sector, and obviate the necessity of arguing for a lower discount rate when planning forestry projects. This will be consistent with the objective of sustainable forestry and the concept of multiple-use–management forestry. To this end the basic exchange model is examined, and the various forestry intangibles are detailed under its framework. Various methods have been used to estimate the value of environment in general and these include primarily contingent valuation technique, opportunity cost method and its variants, travel cost method, hedonic price function, among others.

However, applying the basic exchange value model to forestry projects requires it to be dynamized and which requires multi-period demand and supply schedules for environmental services emanating from forests. This problem is solved by assumption of constant prices and thus resorting to the social benefit-cost analysis (SBCA). For the purpose of SBCA, the rest of the paper explores how different environmental outputs from forests can be valued. The paper has focussed primarily upon seven categories of environmental outputs from a typical forest; namely, flood control benefits, water production, soil conservation and protection of land productivity, outdoor recreation, biodiversity and conservation, aesthetics and habitat, carbon storage or air purification. Different approaches which have been used to the value these environmental benefits are r reviewed. It is suggested that the social benefit-cost analysis can be fruitfully applied to forestry projects if we can value the forestry intangibles appropriately.

REFERENCES

Abouchar, A., **Transportation Economics and Public Policy with Urban Extensions**, John Wiley: New York, 1977.

Adger, W. W., K. Brown, R. Cervigni, and D. Moran (1995), "Total Economic Value of Forests in Mexico", **Ambio**, 24(5): 286-295.

Anderson, D. (1990), Carbon Fixing from an Economic Perspective , Paper presented at the Forestry Commission's First Economics Research Conference, York University.

Anderson R. J. and T. Crooker (1971), "Air Pollution and Residential Property Values", **Urban Studies**, 8: 171-180.

Armstrong, (1974), "Valuation of Amenity Forests ", **The Consultant**, 19 (1) : 13-19.

Ball, M. (1973), "Recent Empirical Work on the Determinants of Relative House Prices", **Urban Studies**, 10: 213-233.

Balick, M. and Mendelsohn, R. (1992), "Assessing the Economic Value of Traditional Medicines from Tropical rain Forests", **Conservation Biology**, 6(1).

Barret, L.B. and T .E. Waddell , **Costs of Air Pollution Damage: A Status Report**, U.S. Environment Protection Agency, Report No. AP-85, Research, Triangle Park, North Carolina, 1973.

Bartik, T. J. and V. K. Smith, "Urban Amenities and Public Policy", In: E.S. Mills(ed), **Handbook of Regional and Urban Economics**, Vol. 2, Elsevier Science Publishers, 1989, 1207-54pp.

Bell, E. A. 1993, “Mankind and Plants: The Need to Conserve Biodiversity”, **Parasitology**, 106:47-53.

Benson, J. F. and Willis, K. G. (1990), **The Aggregate Value of the Non-Priced Recreation Benefits of Forestry Commission Estate**, Forestry Commission ,

Bishop, J. and Allen, J., **The On-Site Costs of Soil Erosion in Mali**, Environment Department Working Paper No. 21, World bank, Washington D.C., 1989.

Bishop, J. and C. Cicchetti, “Some Institutional and Conceptual Thought on the Measurement of Indirect and Intangible Benefits and Costs” , In: H.M. Peskin and E. D. Seskin (eds), **Cost-Benefit Analysis and Water Pollution Policy**, Washington: The Urban Institute, 1975, 105 –125pp.

Bishop, R. C. and M. P. Welsh (1992), “ Existence Values in the Benefit-Cost Analysis and Damage Assessment”, **Land Economics**, November, 68(4): 405-17.

Bowker, J. M. and J. R. Stoll (1988), “Use of Dichotomous Choice Non-Market Methods to Value the Whooping Crane Resource”, **American Journal of Agricultural Economics**, 50(2): 372-81.

Brooks, K. N. et al., (1982), “Economic Evaluation of Watershed Projects- An Overview Methodology and Application”, **Water Resources Bulletin**, April.

Brookshire, D.S., L. S. Eubanks, and A. Randall (1983), “ Estimating Option Prices and Existence Values for Wildlife Resources”, **Land Economics**, 59(1): 1-15.

Brookshire, D.S. , Thayer, W.D. , Schulze, W.D. and d'Arge, R.C. (1982), "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches", **American Economic Review**, 62:165-177.

Brown, G. and Robert, Mendelshon (1984), "The Hedonic Travel Cost Method", **Review of Economics and Statistics,** 6: 427-33.

Bunnel, F.L. (1976), "Forestry-Wildlife: Whither the Future", **Forestry Chronicle**, 52 (3): 147 –149..

Burton, T.L. and G.P. Wibberly, **Outdoor Recreation in the British Countryside**, London University, Wye College, Studies in Rural Land Use No.5. Ashford, 1965.

Calish, S., R. D. Fight, and Teeguarden, D. E.,(1978), " How Do Non-Timber Values Affect Doughlas-Fir Plantations", **Journal of Forestry**, 76 (4): 217 - 221.

Centre for Social and Economic Research on the Global Environment (CSERGE), 1993, **Mexico Forestry and Conservation Sector Review: Sub-study of Economic Valuation of Forests**, Report to the World bank: Country Department II, Norwich, CSERGE.

Cesario, F. J. (1976), " Value of Time in Recreation Benefit Studies", **Land Economics**, 52 (1) : 32 – 41.

Cesario, F.J. and J.L. Knetsch (1970), "Time Bias in Recreation Benefit Estimates", **Water Resources Research**, 6: 700-704.

Cicchetti, C. J. , A. C. Fisher, and V. K. Smith (1973), “Economic Models and Planning Outdoor Recreations” , **Operations Research,** 21: 1104 –1113.

Cicchetti, C. J. and V. K. Smith (1973), “Congestion, Quality Deterioration, and Optimal Use: Wilderness Recreation in the Spanish Peaks Primitive Area”, **Operations Research**, 21: 1104-1113.

Clawson , M. , **Methods of Measuring the Demand for and Value of Outdoor Recreation** , Resources for the Future, Reprint No. 10 , Washington, 1959.

Clawson, M. and Knetsch J.L., **Economics of Outdoor Recreation,** Baltimore: John Hopkins Press, 1966.

Clayton, C. and R, Mendelshon (1993), “ The value of Watchable Wildlife: A Case Study of McNeil River:, **Journal of Environmental Management**, 39:101-106.

Desvousges, W. H. , and V. K. Smith, and A . Fisher (1987), “ Option Price Estimates for water Quality Improvements: A Contigent Valuation Study for the Monongahela River “, **Journal of Environmental Economics and Management** , 14: 248-67.

Diamond, P. A. and J. A. Hausman (1994), “ Contingent Valuation: Is Some Number Better than No Number?”, **Journal of Economic Perspective**, 8: 45-64.

Dixon, J. A. and M.M. Hufschmidt (eds), (1986), **Economic Valuation Technique for the Environment: A Case Study of Workbook**, Baltimore:John Hopkins University Press.

Dixon, J.A., Fallon S., R. A. Carpenter, P. B. Sherman (1994), **Economic Analysis of the Environmental Impacts**, London: Earthscan Publications.

Duerr, W. A. **Fundamentals of Forestry Economics**, McGraw -Hill: New York, 1960, 579pp.

Echeverria, J., M.Hanahan, R. Solorzano (1995), “Valuation of Non-Priced Amenities Provided by the Biological Resources within the Monteverde Cloud Forest Preserve, Costa Rica”, **Ecological Economics**, 13: 43-52.

Farnsworth, N.R. and Soejarto, D. D. (1985), “Potential Consequences of Plant Extinction in the United States on the Current and Future Availability of Prescription Drugs” , **Economic Botany**, 39: 231-240.

Fisher, A., McClelland, G. H., and Schulze, W. D. (1998), **"Measures of Willingness to Pay versus Willingness to Accept: Evidence, Explanation, and Potential Reconciliation"**, In: Peterson, G.L., Driver, B.L., Gregory, R., Amenity Resource Valuation: Integrating Economics with Other Disciplines, 1988, pp. 127-134. State College, Pennsylvania: Venture Publishing.

Foster, D. G. and Beesley, M.E. (1963), “Estimating the Social Benefits of Constructing an Underground Railway in London”, **Journal of Royal Statistical Society**, Series A, 126 (1): 46 – 78.

Freeman, A. M. **The Benefits of Environmental Improvement : Theory and Practice**, Baltimore: John Hopkins University Press, 1979.

Freeman, A. M.(1993), **The Measurement of Environmental and Resource Values**, Washington, D.C.: Resources for the Future.

Garrod, G. D. and K. G. Wills, “ Valuing Biodiversity and Nature Conservation at a Local Level”, **Biodiversity and Conservation**, 3: 555-565.

Gowdy, J. M. (1997), “ The Value of Biodiversity: Markets, Society, and Ecosystems”, **Land Economics**, 73(1): 25-41.

Grayson, A. J. (1989), **Carbon Dioxide, Global Warming and Forestry**, Research Information Note 146, Forestry Commission.

Gregersen, H. , A. Lundgren, T. Graham-Tomasi, K. Kanel, N. Myers, J.Holler, Z. Xu **Valuing the Contributions of Forests of Human Welfare: Theory and Practice,** St. Paul, Minnesota: Forestry for Sustainable Development Program, FAO, 1990.

Gregersen, H,, J,E.M. arnold, A Lundgren, A. Contrears-Herrmosilla, M.R. de Montalembert, D. Gow, **Assessing Forestry Project Impacts: Issues and Strategies, Food and Agriculture**, Rome, 1993.

Gregersen H.M., J.E.M. Arnold, A.L. Lundgren, A Contreas-Hermisilla, **Valuing Forests: Contexts, Issues, and Guidelines**, Food and Agriculture Organization, 1995.

Griliches, Z. (1958), “ Research Costs and Social Returns: Hybrid Corn and Related Innovations”, **American Economic Review**, 66: 419 - 431.

Gupta, T. R. and Foster J.H. (1975), “ Economic.Criteria for Freshwater Wetand Policy in Massachusetts”, . **American Journal of Agricultural Economics**, 57:40 - 45 .

Hagen, D. A. , J.W. Vincent, and P. G. Welle (1991), **The Benefits of Preserving Old-Growth Forests and and the Northern Spotted Owl**, Department of Economics, West Washington University, Bellingham, 41p.

Hammack, J. and Brown, G. M., **Waterfowl and Wet Lands: Towards Bio-Economic Analysis,** Baltimore: John Hopkins Press, 1974.

Hanemann, W.M. (1994), " Valuing the Environment through Contingent Valuation" **Journal of Economic Perspectives**, 8: 19-44.

Hanley, N. , Clive S., and L. Walker (1995), " Problems in Valuing the Benefits of Biodiversity Protection", **Environmental and Resource Economics,** 5: 249-272.

Hartman, R. (1975), "The Harvesting Decision When the Standing Forest Has Value", **Economic Inquiry ,** 14 : 52-58.

Heady, E. 1952, **Economics of Agricultural Production and Resource Use ,** New York: Prentice Hall, 850pp.

Hoch, I. (1974), " Wages , Climate and Quality of Life" , **Journal of Environmental Economics and Management**, 1:268-295.

Hotelling, H. Dated 1947, Letter to National Park Service, In: **An Economic Study of the Monetary Evaluation of Recreation in the National Parks**, U. S. Department of the Interior, National Park Service and Recreational Planning Division, 1949.

Hufschmidt, M. M. et al (1983), **Environment, Natural Systems, and Development: An Economic Valution Guide**, Baltimore and London: John Hopkins

James, L. D. and P. R. Lee, **Economics of Water Resources Planning**, New York: McGraw-Hill, 1971, 615pp.

Johansson, P., **The Economic Theory and Measurement of Environmental Benefits**, London: Cambridge University Press, 1987.

Kain, J. and J. Quigley , **Housing Markets and Racial Discrimination**, New York: Columbia University Press, 1975.

Kramer, R. A. and D. E. Mercer (1997), " Valuing a Global Environmental Good: US Residents' Willingness to Pay to Protect Tropical Rain Forests", **Land Economics**, 73(2): 196-210.

Layard, P.R. and Walters, A.A. , " Externality, Taxes, and Subsidies", In: Lin S.A.Y (ed), **Theory and Measurement of Economic Externalities**, New York: Academic press, 1978.

Loomis, J.B. and D. S. White (1996), " Economic Values of Increasingly Rare Endangered Fish", **Fisheries**, 21(11):6-11.

Lumby, A.B. and Saville, A D. (1995), **Dynamic Efficiency: A Reassessment of the Conventional Discounting Approach to Public Project Appraisal**, Durban, South Africa: Economic Research Unit, Occassional Paper No. 31.

Marsh. G. P., **Man and Nature**, Cambridge: Cambridge University Press, 1965, 472pp.

McConnel, K.E. and I. E. Strand (1981), "Measuring the Cost of Time in Recreation Demand Analysis", **American Journal of Agricultural Economics**, 63: 153-156.

McKillop, W. (1991), **A Critique of the Use of Non-Market Values in the US Fish and Wildlife Services**, August 1991 Report Titled " Economic Analysis of Designation of Critical Habitat for the Northern Spotted Owl" American Forest Resource Alliance, Washington DC, Technical Bulletin, 1991.

Mesewitz, L. (1966), "Recreational Benefits of Water Resource Development ", **Water Resources Research**, 214 : 625-640.

Michaels, R.G. and V. K. Smith (1990), " Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Sites", **Journal of Urban Economics**, 28:223-242.

Mitchell, R.C. and Carson, R.T., **Using Surveys to Value Public Goods: The Contingent Valuation Method,** Washington DC: Resources for the Future, 1989.

Montgomery, C. A. and R. A. Pollock (1996), "Economics and Biodiversity: Weighing Benefits and Costs of Conservation", **Journal of Forestry**, 94(2):34-38.

Munasinghe, M. (1993), Environmental Economics and Biodiversity Management in Developing Countries, **Ambio**, 22(2/3): 126-135.

Nautiyal, J.C. and Rezende, J.L.(1983), " Dynamic Investment Considerations in Forestry Project Evaluations", **Canadian Journal of Forestry Research,** 13: 640 -647.

Payne, B. R., White, W.B. , McCay, R.E. , and McNichols , R.R., **Economic Analysis of the Gypsey Moth Problem in the Northeast II : Applied to**

Residential Property, U.S. Department of Agriculture, Forest Service, Research Paper NE-285, Pennsylvania., 1973.

Pearce, D. and D. Moran, **The Economic Value of Biodiversity**, EarthScan Publications, London, 1994, 172pp.

Pearce, D. and Markandya, A. **Environmental Policy Benefits: Monetary Valuation,** Paris: OECD, 1989.

Pearce, D. and Moran, D. (1994), The Economic Value of Biodiversity, London: Earthscan Publications.

Pearce, D., **Economic Values and the Natural World**, London: Earthscan Publication, 1993.

Pearce, D.W. and A. Walsh, **The Social Appraisal of Projects**, London: MacMillan, 1981.

Principe, P. P. 1991, Valuing the Biodiversity of Medicinal Plants, In: Heywood, V. and Synge, H. (Eds), **The Conservation of Medicinal Plants**, Cambridge: Cambridge University press, pp. 79-124.

Randall, A. , Berry I. And Clyde, E. (1974), " Bidding Games for Valuation of Aesthetic Environmental Improvements", **Journal of Environmental Economics and Management**, 1: 132-49.

Rasmussen, R. A. and F. W. Went (1965), "Volatile Organic Material of Plant Origin in the Atmoshphere", **Proceeding of National Academy of science**, 53:215-220.

Rezende, A., **Evaluating Forestry Projects**,, Ph. D. Thesis, Faculty of Forestry, University of Toronto, Canada, 1978.

Ridker, R. G. and J. A. Henning (1967), " The Determinants of Residential Property Values with Special Reference to Air Pollution", **Review of Economics and Statistics**, 49:246-257.

Roback, J. (1982), " Wages, Rents, and the Quality of Life", **Journal of Political Economy**, 90:1257-1278.

Rosen, S. (1974), " Hedonic Prices and Implicit Markets: Product Differtiantiation in Pure Competition" , **Journal of Political Economy**, 82: 34-55.

Rubin, J. , G. Helfand, and J. Loomis (1991), " A Benefit-Cost Analysis of the Northern Spotted Owl: Results from Contingent Valuation Survey," **Journal of Forestry**, 89(12):25-30.

Ruitenbeek, H.J., "Social Cost-Benefit Analysis" **Appendix 13 of The Korup Project : Plan for Developing the Korup National Park and its Support Zone**, Ministry of Plan and Regional Development, Cameroon, 1989.

Samuelson. P.A. (1954), " The Pure Theory of Public Expenditure", **The Review of Economics and Staistics**, 36:387-389.

Schulze, W. et al. (1983), "The Economic Benefits of Preserving Visibility in the National Perklands of the Southwest", **Natural Resources Journal**, 23 : .

Schwartz, A. (1973), "Interpreting the Effects of Distance on Migration" , **Journal of Political Economy,** 81(5): 1153 - 1169.

Sebastiao kengen, **Forest Valuation for Decision-making: Lessons of Experience and Proposals for Improvement**, Food and Agriculture Organization, Rome, 1997.

Sedjo, R. A. and Solomon, A. M. (1989), "Climate and Forets", In: Rosenberg, N. J., Easterling , W. E. , Crosson, P. R., and Darmstadter. J. (Eds), **Greenhouse Warming : Abatement and Adaption** , Resources for the Future, Washington DC.

Sinden, J. A. and Worrel, A. C., **Unpriced Values: Decisions without Market Prices**, New York : John Wiley, 1979, 511pp.

Smith, V. K. (1983), " The Role of Site and Job Characteristics in Hedonic Wage Models", **Journal of Urban Economics**, 13: 296-321.

Smith, V. K. (1989), " Taking Stock of Progress with Travel Cost Recreation Demand Methods: Theory and Implementation", **Marine Resource Economics**, 6: 279-310.

Smith, V. K. (1993), " Nonmarket Valuation of Environmental Resources: An Interpretative Appraisal" , **Land Economics**, 69(1): 1-26.

Smith, V. K. and Ju Chin Huang (1993), " Hedonic Models and Air pollution: Twenty Five Years and Counting", **Environmental and Resource Economics**, 3: 381-394.

Smith, V. K. and T. A. Deyak (1975), " Measuring the Impact of Air pollution on Property Values", **Journal of Regional Science**, 15:277-288.

Smith, V. K. and Yoshiaki Kaoru (1987), " The Hedonic Travel Cost model: A View from the Trenches" , **Land Economics**, 63(2): 179-192. **Social Science Research**, 2(1) :15-30.

Stevens, T., Echeverria, J., Glass, R., Hager, T., and More, T. (1991, "Measuring the Existence Values of Wildlife: What Do CVM Existence Values Show?" , **Land Economics**, 67(4):390-400.

Storey, H.E. et al, "Hydrology of Forest Land and Range Lands", In: Ven Te Chew (ed), **Handbook of Applied Technology**, New York : Mcgraw-Hill, 1964.

Tewari, D. D., Nautiyal, J.C., and K. Singh (1990), "Incorporating Environmental Impacts of Afforestation in Project Appraisal: A Case Study of Western Himalayas, India", **Journal of Environmental Systems**, 19:339 - 347.

Tewari, D. D. and A. G. Isemonger, "Some Guidelines for Evaluating the Environmental Impacts of Forestry Projects", In: Bachelard, E. P. and A.G. Brown, **Preparing for the 21st Century**, ANZIF Conference, 21-24 April, 1997, pp 287-294.

Tewari, D. D. **Commercial Forestry and Deteriorating Environment in South Africa: Changing Institutional and Policy Needs**, Draft Paper, 1998.

Tobias , D. and Mendelshon, R. (1991), "Valuing Ecotourism in a Tropical Rain Forest Reserve", **Ambio** , 20 (2): 91-93.

Varian, H.R. , **Microeconomic Analysis,** New York:: WW Norton and Company, 1978, 284pp.

Vincent, J.R., E.W. Crawford, J.P. Hoehn (Eds) (1991), **Valuing Environmental Benefits in Developing Economies**, Proceedings of Seminar Series, Michigan State University, East Lansing, Michigan.

Waddel, T. E. , **The Economic Damages of Air Pollution**, U.S. Environmental Protection Agency, Report EPA-60015-74-012. Washington: EPA, 1974.

Walsh, R.G. , Bjonback, R.D., Aitken, R. A. , and Rosenthal, D. H. (1990), "Estimating the Public Benefits of Protecting Forest Quality", **Journal of Environmental Management**, 30: 175-189.

Wibe , S. (1990), **Market and intervention Failures in Swedish Forestry**, Paper submitted to the Environment Committee Group of Economic Experts, OECD.

Wiggins, S.L. and Palma, O.G. , **Acelhuate River Catchment Management Project, El Salvador: Cost –Benefit Analysis of Soil Conservation**, ODA Land Resources Development Center, UK, 1980.

Willis, K.G. and Benson, J. F. (1988), "A Comparison of User Benefits and Costs of Nature Conservation at Three Nature Reserves", **Regional Studies**, 22: 417-428.

Winpenny, J.T. , **Values for the Environment: A Guide to Economic Appraisal,** London: HMSO, 1991.

Witte A. D. and S. K. Lang (1980), " Evaluating the Effects of Public Policies on Land Prices in Metroplitan Areas: Some suggested Approaches" , In: J. T. Black and J. E. Hoben (eds), **Urban Land Markets: Price Indices, Supply**

Measures, and Public Policy Effects, Washington DC, Urban land Institute, 1980.

Zerbe, R. 0. and Dively , D. D., **Benefit Cost Analysis: In Theory and Practice**, New York: Harper Collins, 1994.

Zon, R (1935), "Shelterbelts: Futile Dream or Workable Plan", **Science,** 81:391-394.

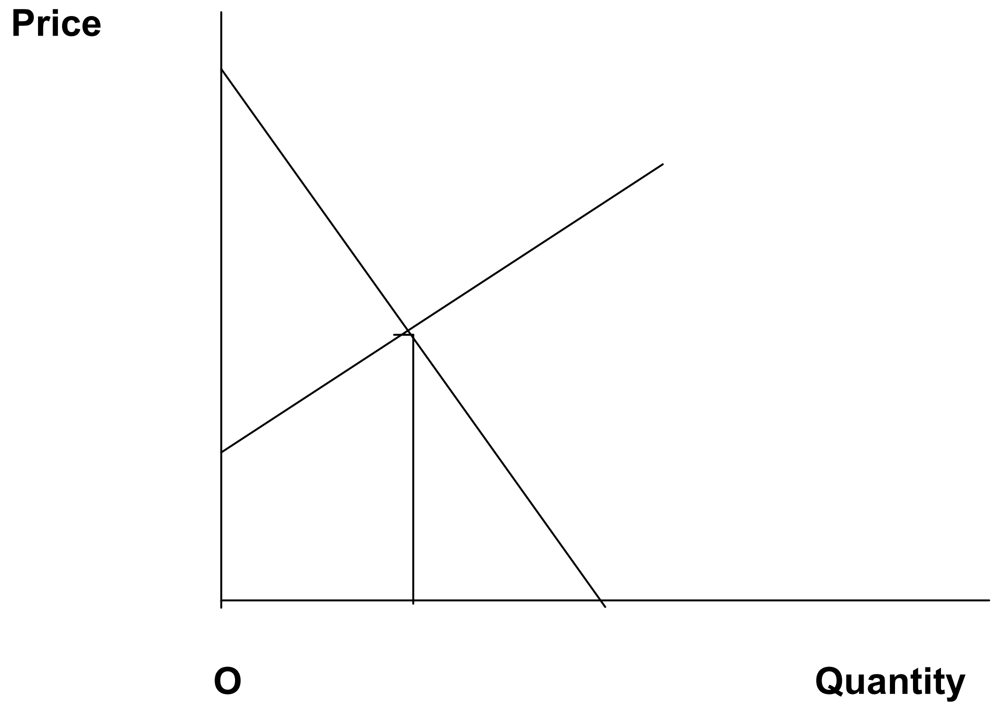

Figure 1: Valuing Environment in the Basic Exchange Model

ENDNOTES

[1] Outputs from a forest can be classified into three broad categories: timber, nontimber, and environmental services. Timber outputs include lumber, plywood, veneers, poles, pulpwood, charcoal, and others. The nontimber outputs include gums/resins, flowers and fruits, seeds and seed derivatives, leaves, root and stem bark, fuelwood, animals, birds, fish, insects, bees, medicinal plants. Environmental services emanating from forests include: soil and water conservation effects, flood control, outdoor recreation, germplasm preservation, aesthetics, wildlife conservation, and so forth.

[2] The magnitudes of environmental benefits from forests are at times estimated to be more than the tangible benefits (Calish, Fight, and Teeguarden, 1978). This evidence has been sometimes used by some experts as an argument for rationalizing non-cutting of forests for tangible gains such as timber (Hartman, 1976).

[3] The developing countries conserve forests beyond their own needs for the sake of global gain need to be compensated by the developed countries who contribute largely to global environmental concerns such as greenhouse effect, ozone hole, etc.

[4] These reasons include, inter alia, the fact that environmental research is often time consuming, laborious and requires field work. Other less time and effort intensive problem-solving projects often take priority in the use of limited funds; the estimation of environmental impacts require a large and specific nature of data set which is costly to collect. Too often economists end up data mining the national accounts due to the data availability problems. This acts as a disincentive for those thinking of undertaking such research projects, particularly when there is a paucity of funds; an awareness of environmental issues is often lacking in developing countries primarily due to ignorance and lack of concern about the long-run role that environment can play in shaping of lifestyles and generating economic growth. Also, perhaps, the environment is still not perceived to be a serious constraint on economic

development as it is in the developed countries. In recent years, a number of studies have come up in the context of developing countries. For example, see Vincent et al (1991), Winpenny (1991). It is important to note that valuation excercizes in the developed world are not sufficiently advanced to give many insights towards determining environmental priorities in the developing world and the information from the developed world is not easily transferable to the developing countries (Pearce, 1993, p. 63).

[5] A voluminous work on the valuation of forestry outputs in the form of field manuals exists. More specific works that need to be mentioned are: Sebastio Kengen (1997), Gregersen, et al (1993), Gregersen et al (1995).

[6] Economic value associated with forests can be classified into four categories: (1) direst use values such as the value of timber and nontimber outputs of forests; (2) indirect use values such the value of environmental benefits emanating from forests; (3) option values; (4) existence and bequest value. We are basically concerned in this paper with the latter three values., and more specifically with the values associated with the environmental impacts of forests.

[7] Although theoretically the willingness to pay (WTP) must equal to willingness to accept (WTA), empirical evidence suggests contrary; the WTA has been found significantly greater than the corresponding WTP (Fisher et al, 1998).

[8] A variety of CVM techniques are used such as bidding games, take-it-or-leave-it experiment, tradeoff games, costless choice, and Delphi technique.

[9] Various criticisms are levied against the CVM over the years and several efforts have gone into validating the method. For details of the debate, see Brookshire et. al. (1982), Freeman (1979), Johansson (1987), and Mitchell and Carson (1989) .

[10] For details on the preventive expenditure (PE) and the replacement cost (RC) methods, see Winpenny (1991. p.48). The PE measures area (b+c) and ignores the area consumer surplus area (a) while the RC measures only area (c).

[11] For a brief review of the state of art of travel cost demand models , see Smith (1989).

[12] For various applications of hedonic price models, see Ridker and Henning (1967), Kain and Quigley (1975), Michaels and Smith (1990), Smith and Huang (1993). Further, for detailed reviews of this model, see Ball (1973), Freeman (1979), Witte and Lang (1980).

[13] Some people have however questioned the use of discounting as such. This paper does not take issue with the suitability of using discounting procedures when assessing the viability of public projects. For a concise summary of the problems, alternatives and a literature review, see Lumby and Saville (1995).

[14] This can be defended on the ground that forestry sector as such forms a very small part of many economies as such; the contribution hovering around 3 to 5 percent of the gross domestic product of many countries.

[15] This may not be true for plantation forestry and problems of water depletion, destruction of scenery, etc., can result. But, this should not pose problem in conducting the social benefit-cost analysis, for these damages can be treated as negative benefits of plantation forestry and thus cost side still remains unchanged.

[16] The carbon sequestration depends upon the species mix, the organic matter content of the species, the age distribution of the tree stands, soil and climate factors (Adger, et al, 1995).

[17] A variant of carbon-tax approach is used by Anderson (1990) to UK forestry and he suggests a carbon fixing value of £43 per cubic meter of timber or £5000 per ha per annum.