VALUATION OF ENVIRONMENTAL IMPACTS OF FORESTRY PROJECTS

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INTRODUCTION

Benefits from afforestation projects or schemes arise in both tangible and intangible forms. Tangible benefits from forest include marketable commodities such as wood, leaves, minor forest produce, while intangibles comprise nonmarketable or environmental commodities or impacts such as soil and water conservation, aesthetics, clean air, and so on. Tangible benefits accrue to individuals and are of private nature but the intangible benefits accrue to the society as a whole and are of public nature. Both tangible and intangible products of forestry projects are jointly produced. Prior to the second World War, the private or timber outputs of forestry projects were in much demand, and nontimber or environmental impacts did not matter much and appear as constraints for economic progress. However, after the War, the demand for public or nontimber benefits has increased significantly. This increase has possibly come by for two reasons. One, the societies at large are realizing that a policy of mere maximizing economic growth without having adequate concerns for deteriorating environment is self-destructive and that nontimber products from forests play an important role in maintaining a balance between economy and ecology. Two, many a time the magnitudes of nontimber benefits from forests are estimated to be more than the timber benefits (Calish et al 1970); this fact has been sometimes used as an argument for rationalizing noncutting of timber or forests (Hartman 1976). As a result, the revised new objective of forestry projects is now to maximize the total benefits, i.e. both timber and nontimber products.

It is generally said that forestry projects have a low rate of return which, in turn, is used by planners for justifying low investment in the forstry sector. Hence, conservationists and environmentalists have asked for a special status or treatment of forestry projects because of their special characteristics such as the long gestation period, joint production of timber and nontimber products, risk, and their strategic role in the economy among others. On this ground, they have argued for using lower discount rate for forestry projects. However, the major flaw with this argument is that this so-called low rate of return is computed without including environmental impacts/benefits emanating from forests. This logic of low discount rate can rather be challenged and due importance to forestry projects can still be assigned if intangible nontimber or environmental impacts can be valued and accounted while computing the rate of return (Nautiyal and Rezende 1983). But the major bottleneck in doing so is the lack of hard data on intangibles. Both price and quantity of nontimber products are difficult to estimate because there exist no markets for or price tags on them, as opposed to estimation of tangible timber benefits as their quantities and prices are available and can be ascertained.

The research work on valuing environmental impacts of forestry projects is not very enthusiastic in both developed and developing countries. Indifferentness towards this in the developing countries is primarily due to the following reasons. Firstly, such researches do not yield quick and direct returns, and other quick-yielding and problem-solving projects in priority preempt the limited research funds. Secondly, estimation of environmental impacts requires a large and specific nature of data set which is costly to collect. This disuades one to undertake such research projects, particularly when there is a paucity of funds. Thirdly, presumably the environmental consciousness is lacking in these countries, primarily due to ignorance and lack of awareness about the long-run role that environment plays in their life styles. Also, perhaps environment is still not perceived as a serious constraint or threat for economic development as has been perceived in the developed countries. Besides these practical constraints, several conceptual problems encounterd in valuing environmental impacts are not sorted out yet, which would provide a base for more rigorous empirical work. The primary objective of this paper is to discuss the methodological and conceptual issues involved in estimating or valuing the environmental impacts of forestry projects. Discussion is arranged as follows. The conceptual model and under which different methods of evaluating intangibles in general are discussed in the next section. This is followed by a revised or modified form of the model which suits to the valuation of intangibles from forestry projects.

APPROACHES TO ESTIMATING INTANGIBLES

Since nontimber products of forestry projects do not have explicit market hence a price tag on them, estimation of their value is a difficult task. Despite the absence of a price tag, a society has still to choose between two alternatives: one, preserving or producing environmental impacts from forestry projects; and, two, cutting forests for agricultural and/or industrial development or leaving the land idle for futher deterioration. The choice depends upon what value a society places on environmental impacts emanating from forests over other alternative uses of land. Or, in other words, the society's choice depends upon the net utility that she derives by consuming or investing in environment-producing /augmenting industries such as forestry sector in a nation (Sinden and Worrel 1979). Yhat is, the value of environmental commodities (V_e) equals to the utility (U_e) gained from their consumption minus the disutility (DU_e) in obtaining the same; or, $V_e = U_e - DU_e$. This is the fundamental value equation of neoclassical economics. Since value in economics implies the power of exchange that a commodity commands, which depends upon the demand for and supply of it, the value of intangibles can be estimated from the demand-supply framework or from the basic model of exchange.

To begin with, suppose demand (marginal benefits) and supply (marginal costs) schedules for intangibles are given as in Figure 1. The negatively sloped marginal benefits or demand schedule implies that as price of intangible environmental commodities is lowered the demand for the same will increase. Similarly, positively sloped supply schedule suggests increasing additional cost for each additional unit of intangibles produced. Intersection of supply and demand schedules determines the equilibrium price P and quantity Q of intangibles. Total utility that society in general, and consumers in particular, receives by consuming Q amount of intangibles is equal to area (a+b+c); costs to the society is represented by area (c). Hence, the net area, (a+b), is net gains to the society and is defined as net social benefits. Of the net social benefits, areas (a) and (b) represent respectively consumers'and producers surpluses. This is the standard value model which should be used ideally for estimation of benefits from intangibles or nontimber products. 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. Grilliches (1958) estimated the value of research on hybrid corn. Similarly, Hammock and Brown (1974) estimated the net benefits resulting from an improvement in management of duck-habitation in North America. However, it is always not so handy to apply the value model in all situations, as demand and supply schedules cannot always be estimated.

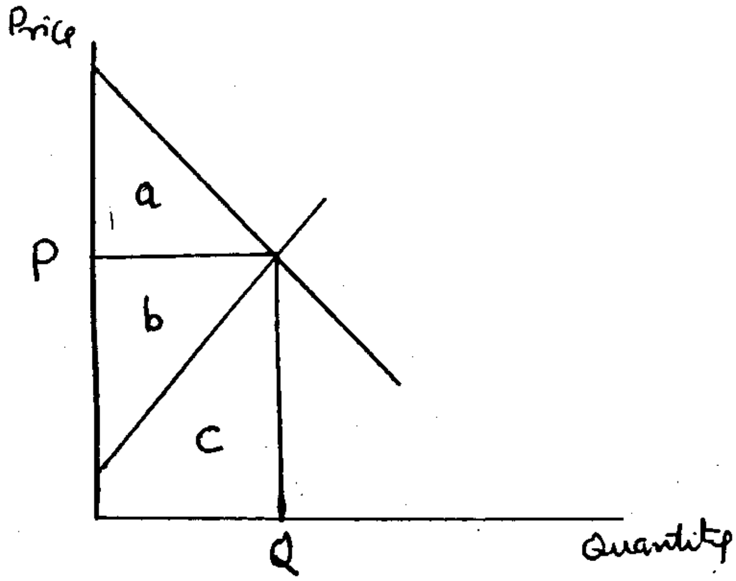

Figure 1: Valuation of Intangibles in Basic Exchange Model

Hence, various other approaches or methods or group of methods used in the past have partially implemented the value model. We would briefly discuss them below. For example, some methods tend to estimate area (a+b+c) as willingness to pay of affected individuals through surveys. An example of this is when we ask that how much pollution affected individuals would like to pay for not sacrificing the clean air. Such methods are grouped under the heading of surveys and bidding games techniques. Barret and Waddel (1973) used this approach to estimate the value of clean air. Two major problems that are encountered with this approach are that the results of survey may not be representative for several reasons and that the responses may be affected by the individuals' beliefs.

Sometimes consumers expenditures or area (a+b) in Figure 1 is taken as a proxy for benefits from consumption of intangibles. Thus area (a) or consumer surplus is ignored. For example, Burton and Wibberby (1905) equated benefits of recreation with consumers expenditures.

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 fact 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 costs incurred or area (c) in the value model. Here, the both consumer and producer 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. In this context, a variety of opportunity cost methods are devised with some modification from one to other. Sometimes unpriced things can be valued or accounted for through cost of replacing or maintaining them. For example, many a researchers have suggested that benefits from flood and fire protection can be equated to replacement costs or damages that are avoided. Or, 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

(Schwatz 1973). Sometimes, savings in social costs resulting from new environment-augmenting technology, such as water pollution control, can be taken as *net benefits* of the environment. For example, Foster and Beesley (1963) estimated the value of convenience of a seat on a *commuter train*, in comparison to the inconvenience of standing and *holding* a strap, in which cost-savings were measured in terms of *time*.

The travel-cost *method* is commonly used for valuation of outdoor recreation. This was originally developed by Knetsch and Clawson (1964), although since then many refinements have been made. The method measures the consumer surplus from outdoor recreation with a restricted assumption that the consumer surplus obtained by marginal user is nil. Since 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 $Q_i = f(P_1, X_1, \ldots X_n)$; where Q_1 is the quantity of visits taken per unit of time, P_1 is price of a visit, X_1 to X_n are income and other explanatory variables. Since P_1 is not directly observable, several other proxies can be used: travel-cost, travel-cost plus entry fee, distance (Clawson; Clawson and Knetsch; Sinden; Mesewitz; and Mansfield). 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 that the greater the travel distance the lesser attractive a site becomes and thus involves the loss of leisure time (McConnell). Although there are various measures suggested to take into account this such as shadow prices of leisure, wage rate, and other (Cesario; McConnel), disagreements among experts still remain as to how to evaluate leisure time.

A more objective method for estimating environmental benefits rests on measuring indirect effects of environment on market goods. 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 problems have indirect effects upon the values of real-estate. In this case, land or real-estate values can be regressed on appropriate indices of environmental variables along with other usual variables, In this way hedonic prices, which represent the marginal willingness to pay, to the environment variables can be estimated directly or with some manipulation of estimated regression-coefficients depending upon the utility function assumed (Pearce and Nash, pp. 136-139). A specific case of hedonic price estimation is the land-price method in which land values are regressed on approroriate indices of intangibles as explanatory variables.The land-price method has been used to estimate: the values of trees (Payne et al); amending or aesthetic value of forests (Armstrong 1974); value of clean air (Waddel 1974); social benefits from wetlands preservation (Gupta and Foster 1975). A other variant of the land-price method is one in which willingness to pay, instead of land price, is used as dependent variable (Bishop and Cichetti). 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.

APPLYING VALUE MODEL TO FORESTRY PROJECTS

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

There are two major conceptual problems in applying this dynamic value model for estimating the value of nontimber products. In the first place, it requires knowledge of marginal benefits/costs of each nontimber product for each year, and there are serious conceptual problems in obtaining the same, in addition to many practical ones. The problem in determining marginal benefits lies in the fact that most of the nontimber products are jointly produced with timber products and have the nature of public goods and externalities. Also, due to joint production process, aportioning of costs between two products of different nature, market and nonmarket, is difficult because of 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 benifit, irrespective of whether products are produced in fixed or variable proportions (Heady; Duerr). Conceptual problems also arise in how to allocate fixed costs between timber and nontimber outputs. Allocation of fixed costs according to the contribution of each product in total revenue cannot be applied because only contribution of timber products 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--timber and nontimber--can be produced in a fixed or variable proportion. If a fixed proportion is assumed, then amount of nonmarket or nontimber 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 but not soil and water conservation, while some slow-growing species maximize soil conservation at the expense of timber. Furthermore, the knowledge about the production function of forestry is also limited, a sound production function is not known even for timber (Duerr). Hence estimating a relationship between timber and nontimber products is almost impossible with the present stock of knowledge. 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.

In the second place, even if marginal benefits/costs scedules can be estimated for each year, an appropriate procedure is required to aggregate them. This is because a benefit received now is worth more than that received later. A wood owner would rather prefer Rs. 1000 today instead of 50 years from now, the reason being that he can gainfully invest this money elsewhere. Similarly an expense or cost incurred today is more costly than that would be incurred 50 years from now. Fortunately this can be done through discounting procedure. That is, the future values are discounted to the present using some appropriate discount rate. The choice of discount rate depends upon the time preference which would be different for a society than that 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.

Hence, if multiperiod demand and supply schedules for environmental impacts can be estimated, then net social benefits resulting from environmental impacts can be aggregated through discount procedure. However, estimation of marginal benefit/cost schedule for each year of econmic life of forests is a difficult task as future prices are not known. But, one way to get by this is by rationalizing the assumption of constant prices on the ground that forestry projects are not generally large enough to alter general price levels. This means that simple costs and benefits based on fixed prices can be computed and can be used to estimate the value of nontimber benefits. Thus we need not estimate the demand and supply schedules for nontimber products for each year. Thus, timber or private and nontimber or public benefits emnating from forests can be assigned a value each year. Similarly on the cost side, costs of resoures can be assigned value; however, in this case costs are same to both timber and nontimber outputs and we need not allocated costs to them differently. That is, unlike private and public benefits, private and public (social) costs are one and the same as there are possibly no negative externalities from forestry projects. Thus social benefit-cost analysis can be applied for evaluation of environmental impacts of forestry projects.

In the social BCA , the valuation of timber products and resources used in the foresty projects can be valued using their optimal prices and quantities from markets, although prices have to corrected if they deviate from socially optimal levels. But, the difficult part is to estimate the nontimber or public benefits of forestry projects since there exist no markets for them. we do not know prices or as well as their quantities produce. In fact, it is the major problem in applying social BCA to forestry projects (Nautiyal and Rezende).

The problem arises because the nontimber products from forests appear as public good or public good externalities for which there are no markets. Absence of markets makes social BCA more difficult to apply than the situation when market price is available eventhough that needs to be corrected if it were not producing socially optimum quantities of products due to market imperfections. Different approaches have been used to value the environmental benefits, and mostly the method of valuation depends upon the characteristics of nontimber products produced by forests. We would briefly review them below.

VALUING NONTIMBER PRODUCTS FOR SOCIAL BCA

Various nontimber products of forests can be grouped under the following headings: flood control, water production, soil conservation, land productivity, aesthetics, air purification or clean air, germplasm preservation, other products such as recreation, and other benfits not listed above. The proportion of each nontimber product may, however, vary from one place to other, one tree specie to other, young to old forests, etc. In what follows is the brief review of various characteristics of public goods produced by forests and suggested method to account for their value for the social BCA.

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 rain water 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). The role of stream regulator is very importan.., particularly in the tropical countries 8wher 60-80% of the mean annual rainfall is received during a short period of 3 to 4 months. In the absence of forest cover, most rainwater is lost through run-off and contributes to overflowing of rivers and floods.

As is known, benefits of flood control are pure public goods (Samuelson, Henderson and Quandt, Abouchar, Layard and Walters, Varian). They are enjoyed not only by the people living in the surrounding areas but lso by those who are situated far away. Generally, flood control benefits are valued as equal to the difference between damages resulting from with and without the flood protection services of forest. However, practical problems arise in estimating flood damages. For example, flood damages in a river basis can vary with the different percentages of forest cover and tree species. Obtaining empirical data for this is a tedious task. Other suggested approach is to use flood insurance premium as a proxy for benefits if an insurance market exists. Costs od flood control can also used as proxy for benefits. However, costs are difficult to allocate because of joint nature of production and lack of knowledge about the timber and nontimber production relationship as discussed earlier in this paper. In addition, estimation of costs of intangible harms (psychic costs) of flood damages is a real problem and these are generally ignored (James and Lee).

A naive but practical approach to value flood control services of forests is to develop a flood protection index (FPI) which can be translated into some monetary values (Rezende). For examples, 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 when it comes to 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, etc.

Water Production

Other nontimber benefit from afforestation is water production. Forests help produce water in two ways. (1) by increasing seepage of rain water which through subsurface flows reaches the streams, and (2) by inducing precipitation. In a deforested area, water reaches the streams immediately after the rainfall in the form of run-off. Afforestation increases seepage and thus streams do not overflow; rather, through subsurface flows the seepage water reaches streams. This water is more equitably distributed over the year. In addition, the quality of this water is better because it is filtered through earth surface (Hewlett and Hibbert). Benefits thus arise not only in terms of quantity of water reaching the stream but also in terms of its quality and timings. Quality and timings may also be affected by the type of tree species and age of the forest. For example, pine tree stand is expected to produce a better quality of water. Timing and quality of water are thus vary valuable to human health.

How to put value upon this water produced by forests? The value of water may be different for different uses. One direct approach is simply to use the cost of producing this water by any alternative means. For example, rainwater can be collected and purified by artificial techniques on surface tanks and then distributed throughout the year. Or other approach is to estimate the value of less of human health due to unavailability of this water produced by forests. All this requires large data which generally do not exist, at least in the developing countries.

Generally it is argued and is accepted view that forests induce precipitation (Zon, Marsh, Rasmussen and Went). Forests at most can increase the precipitation by 5% of the amount of rainfall in a region (Rezende, p.71). In a region where precipitation is lacking, an increase in rainfall by 5% would mean a bit and should be taken into account for social BCA. A very practical way to value this extra rainfall is to estimate the correlation between annual precipitation (including distribution throughout 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 increase or decrease in production, then a rough estimate on value of extra 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. Most times, the extra rainfall generated by 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. Value of water produced thus varies, Calesh et al 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 protected, which otherwise be lost through soil erosion, depends upon several factors, the vegetative or forest cover is one of the most important factor for certain. And, it is specially important if land slopes are very high. One should however note that soil losses resulting from entropy law or what is called geological erosion is not to be included in the social BCA 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 nearby lands. Thus soil conservation benefits are from afforestation are as difficult to value as other environmental benefits. 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). Or, the service of forests in maintaining or recovering the productivity of soils would be reflected in the prices of final private goods produced including 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.

Outdoor Recreation

The outdoor recreational value of forests is well evaluated in the literature, primarily using the travel-cost approach. The travel-cost method estimates the outdoor recreation value by attempting at measuring the recreation demand based on expenditures. The limitations of this method should be well understood as described earlier.

Germplasm Preservation

The value of wildlife or animal is composed of preservation and game values ($V_w = V_p + V_g$). As numbers of an animal 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 commercial use of animal, and preservation becomes strategic. It is perhaps easier to put a value upon game or commercial aspect of an animal or plant species because its reflected in its price. For example, commercial value of wildlife is reflected through price change for each hunted animal or reflected in hunting license fee. But, wildlife diversity being a final and public good poses problem of putting a value on it. Generally wildlife diversity or protection value is associated with the type of forest managament system - intensive and extensive (Clark, Bunnel). 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 if complementary output. For the purpose of social BCA, the value of wildlife protection and diversity can be set equal to zero for the pure tropical plantations where the rotation is short, and, in circumstances where large number of animals are not in danger of extinction and interfering with timber production their value may be negative.

Aesthetics

The aesthetic value of forests arises in terms of pleasure derived by individuals in contemplating a forested 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 monotonicaly as trees grow to maturity (Calish et al). Other things such as hills, valleys, streams, open spaces also add to the aesthetic valued forests (Helliwell). It is therefore possible to overestimate the aesthetic benefits of forests if other things are ignored (Price). Sometimes, removal of some forest area might add to the aesthetic value particularly when they hide some 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 expeted to be much higher than sparsely populated areas.

A Rule of Thumb

However, under the circumstaces where the above objective assessment of of environmental impects of forestry projects are not available, some forest economist have suggested a rule of thumb to assign at least as much value to nontimber output of forests as to timber cost streams remain the same. Tewari et al (1988) have used this approach for valuing the environmental impacts of community afforestation in the Western Himalayas. Further, they have shown that by incorporating environmental impacts of forestry projects in the appraisal the rate return increases significantly.

SUMMARY AND CONCLUSIONS

In this paper, an attempt is made to discuss approaches to valuing environmental impacts of forestry projects. More specifically, how the static basic exchange model can be modified and simplified for valuation of the same. It is suggested that the social benifit-cost analysis can be used to the valuate nontimber products of forestry project; and, different methods to valuing different nontimber outputs are discussed and reviewed.

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