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INCORPORATING ENVIRONMENTAL IMPACTS OF AFFORESTATION IN PROJECT APPRAISAL: A CASE STUDY OF WESTERN HIMALAYAS, INDIA*

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ABSTRACT

Environmental impacts of forestry projects are often ignored in benefit-cost analysis (BCA), primarily due to lack of hard data on them. The valuation of environmental impacts and their inclusion in BCA is all the more important in developing countries where deforestation is causing a major environmental damage. In this article, a BCA is conducted for the community afforestation scheme in the Ramganga catchment in Western Himalayas of India. The article briefly reviews the various methods of valuing different environmental impacts of forestry projects with special reference to the scheme, and provides the social BCA of the scheme using a simple method of accounting for environmental impacts as suggested by some forest economists in situations where objective assessments of the same are not available. Results of the study suggest that social BCA helps improve the ranking of forestry projects under *ceteris paribus* conditions.

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In the Third World where environmental damage is a major factor affecting development activities, assessment of environmental impacts of any investment projects is essential. It is all the more important to do so in afforestation projects because deforestation is the most severe environmental problem in many such countries. A societal or social benefit-cost analysis (SBCA) would be the appropriate way of choosing projects in such circumstances [1]. Unfortunately, however, there are major problems in applying SBCA to forestry projects, as the value of environmental impacts is hard or impossible to assess due to problems encountered in their quantification. We very briefly describe the nature of some of the environmental impacts of afforestation projects and the difficulties involved in evaluating them, and then adopt a rule of thumb, proposed elsewhere, to a community afforestation scheme in the Ramganga catchment in Western Himalayas of India. The results of BCA with and without environmental impacts are compared.

ENVIRONMENTAL IMPACTS OF AFFORESTATION SCHEME

The scheme of afforestation on community lands, which comprise about one-third of the total catchment area of Ramganga river above the Kalagarh dam in Uttar Pradesh was started in 1962. The entire area is in the lesser Himalaya where two types of tree species—*Pinus roxburghii* and *Grewia oppositifolia*, locally known as Chir and Bhimal respectively—were planted. The "private" benefit cost analysis (PBCA) of this scheme has been carried out by Tewari and Singh [2]. However, in doing so, environmental impacts of the scheme were ignored. Since environmental benefits may exceed the direct benefits of forestry projects [3], incorporation of these in the BCA is particularly crucial in the appraisal of such projects.

The environmental benefits of forestry schemes generally go by the name of nontimber benefits and include: 1) soil protection or conservation and increased productivity of lands in the vicinity; 2) reduction in the intensity and frequency of floods in downstream areas; 3) increased availability of water in streams during any season; 4) better quality water (free from silt); 5) possibly of increased local precipitation; 6) preservation of genetic pool in natural areas; and 7) aesthetic values. Although, conceptually it is possible to measure the value of at least some of these benefits, to the best of our knowledge no empirical studies have succeeded in quantifying them.

Soil conservation benefits of the project in Ramganga Catchment could be measured either in terms of value of additional production from the affected lands due to reduced soil erosion made possible by afforestation or in terms of avoidance of loss due to reduction in the life of the Kalagarh reservoir caused by increased siltation in the absence of the scheme. Another approach could be to estimate a perceived price for soil conservation benefits, assuming that they can affect the land or real estate values. In this case, land or real estate values in the catchment can be regressed on indices of soil conservation benefits, and marginal willingness to pay for soil conservation benefits can be estimated directly or by some manipulation of estimated regression coefficient, depending upon the utility function assumed [4, pp. 136-139].

Flood protection services arise mainly due to the fact that forests act as interceptors of rainfall and regulators of water streams. Under Western Himalayan conditions, the reported magnitude of interception under tree cover is about 20 percent of the gross rainfall [5]. Generally speaking, the value of flood control benefits can be assigned as equal to the difference between damages occurring with and without the flood protection services of forests. It has also been suggested that a flood protection index (FPI) be developed which can be translated into some monetary measure [6]. In well-developed insurance markets the change in flood insurance premiums after afforestation could be used as a proxy for the flood protection benefits received from a project. No such flood insurance market exists at present in India. Further, the data problems involved are gigantic and are either not available at all or only in rudimentary form in the Third World countries. Even in the developed countries data are far from adequate if known.

Scientific studies seem to indicate that forests, to some extent, help produce water by 1) increasing seepage of rain water which either augments the stream flows through subsurface flows or recharges ground aquifers; and 2) inducing precipitation [6, p. 76]. Increased seepage due to afforestation makes water more equitably available throughout the year and hence reduces flood damages. Moreover, this is good quality water, filtered through earth surface, and is used by villagers for drinking purposes in the project area. The value of water for BCA may be approximated by estimating increased health costs in the absence of the availability of naturally filtered water or the cost of purifying surface water by any other technique.

Forests can increase the local precipitation at most by 5 percent [6, p. 71]. Rezende has suggested a valuation method for this extra rainfall: set the value of extra rainfall equal to zero, provided the correlation coefficient between annual precipitation and value of total production is insignificant. Or, if 15 percent 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. Otherwise, the value of extra rainfall can be sought from the regression coefficient as a measure of extra value produced by an extra centimeter of rainfall.

Community forests in the catchment may also help protect or preserve germplasm of both plant and animal origin, purify air through photosynthesis, absorb noise, produce anti-desertification effects, increase aesthetic value of the catchment, reduce dust pollution, increase outdoor recreation opportunities, and so on. Putting a monetary value upon these benefits is merely an exercise in guessing.

As obvious from the above, environmental impacts of community afforestation scheme are varied and their quantification or valuation is more difficult, especially as the bulk of information required for valuation by various methods is not available. Here, one should cautiously note that different methods to value environmental impacts approximate the actual benefits and thus do involve errors of estimation. Besides data problems and estimation errors, conceptual difficulties also arise in assigning values to environmental impacts, partly because they are produced jointly with timber products, and knowledge about the production functions of these products is still unclear [1-7].

However, under the circumstances where the above objective assessments 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 nontimber outputs of forests as to timber [1; 6, pp. 162-171; 8, p. 466]. The cost streams do not change as there are few harmful or negative externalities produced by afforestation projects, particularly in a developing country like India. Conceptually, the situation can be viewed as in Figure 1 in which marginal social benefits are twice marginal private benefits, but marginal private and social costs are the same. The net social benefits are equivalent to area (a + b) area b represents the net environmental benefits to the society. Although this rule of thumb is based on limited simulation studies, it is simple, quick, and cost-effective for developing

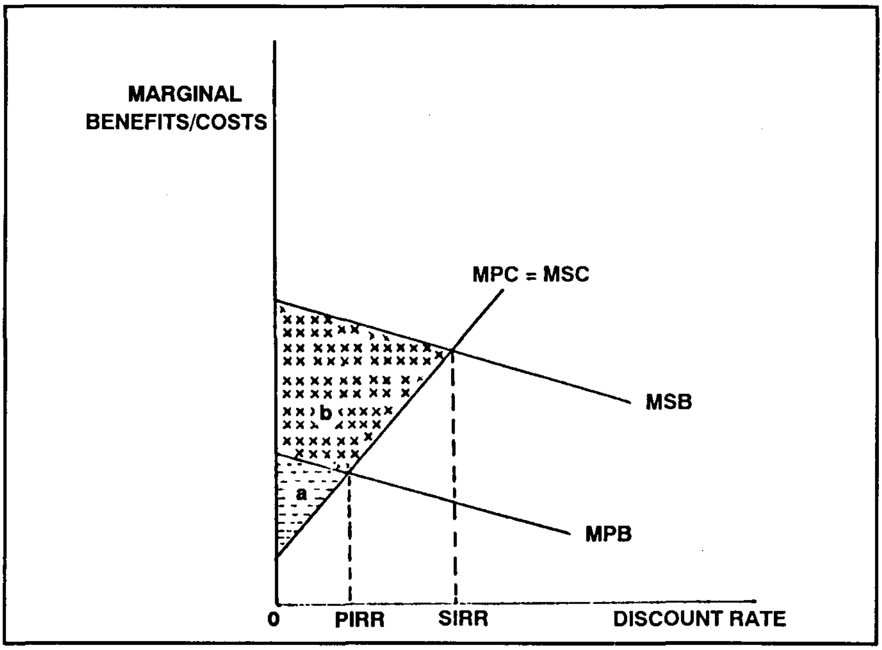

Figure 1. Social and environmental benefits of afforestation projects: A graphical model.

countries where data necessary for measurement and valuation of environmental impacts are difficult to come by.

METHODOLOGY, DATA, AND ESTIMATION

The data used in this paper were derived from an earlier work of authors [2]. The three well-known and widely used criteria of BCA, namely Net Present Value (NPV), Gross Benefit-Cost Ratio (GBCR), and Internal Rate of Return (IRR) were used by us to determine the effect of inclusion of environmental impacts of the scheme on the economic viability of the afforestation project (see [9] for details of these criteria). These criteria were called "private" if environmental impacts as described, i.e., nontimber benefits were excluded and were called "social" if they were included.

The nontimber benefits of the project were estimated at the catchment level. This was done by taking the uniform series of annual social benefits, computed by dividing the NPV per hectare over the rotation period by the appropriate annuity factor, and multiplying it by the area of community lands in the catchment. The contribution of environmental benefits in social welfare was obtained by subtracting the net annual private benefits from the net annual social benefits; the estimates of net annual private benefits were taken from [2]. Both net social and environmental benefits were projected under three Scenarios: Scenario one, afforestation of all the community lands in the catchment (99,249 ha); Scenario two, afforestation of all community lands left after setting aside 50 percent of existing grazing lands to be used as pasture lands (89,605 ha); Scenario three, afforestation of the community lands as under Scenario two but excluding all of the uncultivable wastelands (68,285 ha).

RESULTS AND DISCUSSION

In Table 1, the social and private gross benefit-cost ratios for Bhimal and Chir plantation projects are presented. A perusal of the table reveals that, with the inclusion of environmental impacts in the BCA, both Chir and Bhimal plantation projects appear to be feasible respectively up to 25 percent and 15 percent discount rates compared to that only under or up to 10 percent when environmental impacts are excluded. Similarly incorporation of environmental impacts in the BCA improved the maximum returning capacity or internal rate of return of both projects, as social internal rates of return for Bhimal and Chir are higher by 48.6 percent and 23.8 percent, respectively than their private counterparts. Inclusion of nontimber benefits thus improved the economic viability of the scheme. However it favored Bhimal more than Chir, as the former is a short-duration or quick-returning project.

The private and social net present values for both plantation projects at different discount rates are shown in Figure 2. Note that for all levels of discount rates, the

Table 1. Social and Private Gross Benefit-Cost Ratios for Bhimal and Chir Plantations, Ramganga Catchment, India

	Bhimal GBCRs		*Chir GBCRs*	
Discount rate	*Social*	*Private*	*Social*	*Private*
5	4.42	2.21	7.03	3.54
10	3.28	1.64	2.64	1.29
15	2.30	1.15	1.01	0.51
20	1.56	0.78	0.47	
25	1.05			
30	0.70			

Table 2. Social and Private Internal Rates of Return (IRR) from Afforestation, Ramganga Catchment, India

	IRRs		
Plantation types	*Social (percent)*	*Private (percent)*	*Increase in the rate of return due to nontimber benefits*
Bhimal	25.7	17.3	48.6
Chir	15.1	12.2	23.8

social NPV is greater than private NPV, suggesting the improved feasibility of afforestation schemes at higher discount rates. The area between two NPV schedules can be attributed to the environmental impacts.

The projected net annual flows of social and environmental benefits of both plantation projects for three Scenarios are given in Table 3. The monetary values assigned to both social and environmental benefits are in constant Indian rupees (millions of INR in 1978-79 prices). A perusal of the table reveals that the magnitudes of environmental impacts are of substantial value and range from INR 141 million to INR 21 million depending upon the discount rate, tree species planted, and the Scenario chosen. Furthermore, the proportion of environmental impacts in net social benefits increases as discount rate is increased. For example, the environmental benefits as proportion of net social benefits (computed from Table 3) for Bhimal under Scenario one are given as follows: 64.5 percent, 79.2 percent, 89.4 percent, and 100 percent respectively at 5 percent, 10 percent, 15

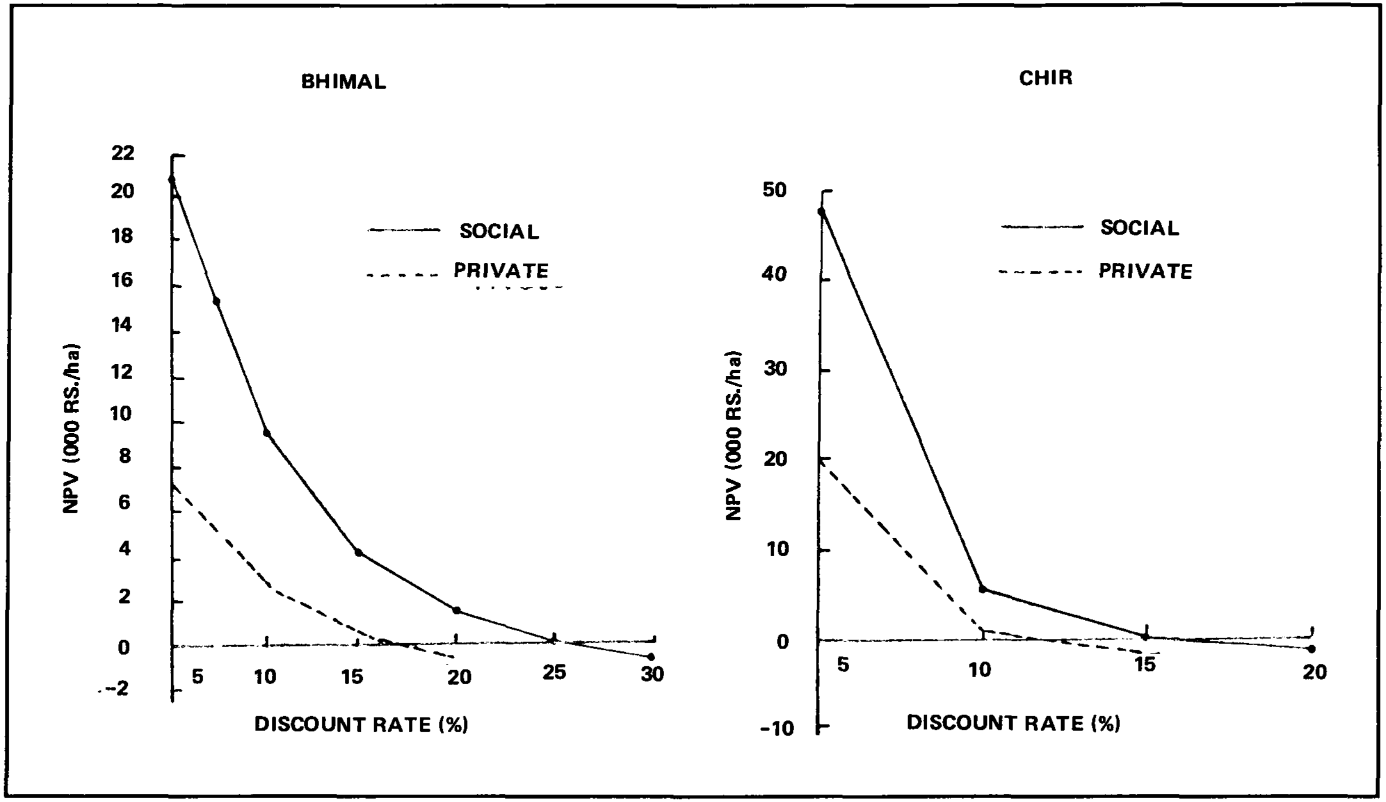

Figure 2. The social and private NPVs of Chir and Bhimal.

Table 3. Uniform Series of Net Annual Social (Timber plus Nontimber) and Environmental (Nontimber) Benefits from Afforestation at the Catchment Level Under Three Scenarios

			Net Social and Environmental Benefits at discount rate of:							
	Tree	*Area*	*5%*		*10%*		*15%*		*20%*	
Scenario	*Spp.*	*(ha)*	*S*	*E*	*S*	*E*	*S*	*E*	*S*	*E*
			Million INR							
First	Bhimal	79249	166	107	111	88	66	59	38	38
	Chir		242	141	56	47	—	—	—	—
Second	Bhimal	89685	150	97	108	72	56	53	27	27
	Chir		212	129	59	42	—	—	—	—
Third	Bhimal	68625	115	74	77	55	46	41	21	21
	Chir		167	97	40	32	—	—	—	—

Note: S — social including both private and environmental benefits. E — environmental benefits only.

percent, and 20 percent discount rates. This type of trend is also visible elsewhere in the table. Although this might have resulted directly from the built-in methodological bias of simply doubling the private benefits in order to account for environmental impact, it does suggest how higher discount rates affect the viability of forestry projects and improves their ranking under *ceteris paribus* conditions.

CONCLUSIONS AND IMPLICATIONS

The major problem in applying BCA to forestry projects is the assessment of various environmental impacts, particularly in the context of developing countries where data on them are difficult to come by. However, under the circumstances when objective assessments of these impacts are not possible to be made, some forest economists have suggested a rule of thumb to assign environmental impacts as much value as the direct timber benefits. This method has potential usefulness for international agencies such as World Bank which are going in a big way to financially support a afforestation projects in developing countries. Further, to impart needed credibility to this simple rule of thumb, research funding agencies in India and outside may initiate a few research projects in selected catchments to monitor and measure the nontimber benefits of afforestation schemes.

Within special reference to the community afforestation scheme in the Western Himalayas, inclusion of environmental impacts in the BCA as suggested by the above method resulted in improved ranking of the forestry project. We therefore disagree with the practice of arbitrarily choosing a low discount rate for forestry projects, as urged by some conservationists and environmentalists, and suggest that more emphasis should be laid on valuation of environmental impacts, so as to impart due importance to them in project appraisal.

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