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INTERNALIZING COMMUNITY IN FOREST CONSERVATION: A DEVELOPING COUNTRY PERSPECTIVE

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ABSTRACT

Forest authorities have been finding it increasingly difficult to protect forests by traditional legal and punitive measures. Many ideas and concepts have emerged over the years such as Forest Protection Committees (FPC), Eco-development Projects, and Joint Forest Management, to address the problem of appropriate management. The basic philosophy behind these concepts is to involve stakeholders in the conservation and management of forests and to give them alternative sources of earnings. This article is an attempt to assess theoretically the justification of stakeholders' participation in the management of forests and empirically to estimate some of the economic and ecological losses when forest authorities fail to involve stakeholders in the process of forest conservation.

INTRODUCTION

Sustainable forest eco-systems are an essential component of environmental conservation. Any degradation of forest will have an adverse effect on climate, ecology, soil fertility, biodiversity, and agriculture. Moreover, the subsistence living of tribal and other communities in and around the forested areas will also be jeopardized. Tropical forests in particular are being destructed at an alarming

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rate [1]. Forests are vital sources of raw materials such as timber, fuel wood, and non-timber forest products (NTFP), such as fruits, bamboos, and many medicinal and edible plants. They are also homes to various plant and animal species. Degradation of forests is likely to disturb the whole complex eco-system. The area of rainforest, mostly located in developing countries, standing at 800 million hectares, is being depleted at a rate of 1.8% per annum [2]. At this rate of depletion, most of the world's rainforest will be destroyed in 50 years time unless policies are put into place to curb the rate of destruction [3]. This is because, worldwide, nearly 700 million people are estimated to live in the periphery of these forests and are heavily dependent on them for their survival [4].

Fortunately, authorities in different countries have responded in part by enacting laws to protect forests from human intervention; e.g., the Government of India declared a National Forest Policy in 1988 [5] by which human intervention is prohibited in protected forests. In fact, the loss of rainforests has become recognized as a major international issue over the last 30 years and was a focus of negotiation at the Earth Summit in Rio in June 1992 and at subsequent follow-up gatherings.

To conserve forests we have to know the causes of forest destruction and find ways to eliminate the causes. Extraction of forest resources for commercial and local interest has been one of the important causes of forest destruction [6]. Kumar and Hotchkiss [7], using data from Nepal, have empirically estimated the links between deforestation, women's time allocation, and effects on nutrition, when women spend longer hours collecting fuel wood. Bluffstone [8] had shown that the presence of off-farm employment prevents forest destruction. Links between forest scarcity and household fuel wood collection are analyzed by Rasmus et al. [9] using a novel Maximum Entropy Estimator. Deacon [10] uses a general equilibrium model to show that government policies that reduce profitability of agriculture accelerate deforestation. On the other hand, there are some economists who hold government policies, which promote agriculture, responsible for loss of forests. Ehui et al. [11] suggests that greater returns to agriculture accelerate deforestation in a dynamic model. In this study, agricultural yield is assumed to be an increasing function of deforestation.

However, the assumption of agricultural yield as an increasing function of deforestation may be unrealistic for protected forests, where the boundaries have been well demarcated, buffer zones between forests and surrounding villages have been established and laws have been enacted to prevent conversion of forest lands to agriculture [12]. Activities relating to conversion of forest lands to farming are clearly visible and can be monitored at relatively low cost. Legal and punitive measures may be effective in controlling the conversion of forest lands to agriculture. In contrast, forest resource extraction activity is not easily detected and legislative measures have not been very effective in controlling it [13]. Over the last decade, approaches to forest management and biodiversity conservation shifted fundamentally from a focus on centralized planning and management by government agencies to a more participatory approach that balances social, environmental, and economic objectives. This article, therefore, is an attempt to assess the effectiveness of the participatory approach to forest conservation.

This article contains five sections. In section II, a time allocation model of a representative household is shown whose total time endowment is allocated between agricultural time and time spent in extraction forest resources. Section III discusses forester's problem in two subsections. Section IIIa discusses the problem of the forester who has to live with illegal forest extraction, incurring policing costs to prevent such illegal extraction. Section IIIb identifies various components of benefits to the forester in a changed scenario when forester is able to convince the local community to refrain from illegal extraction. Section IV deals with the empirical estimation of some of the economic and ecological losses, as in the case of India's Buxa Tiger Reserve Authority, when it failed to involve communities in forest management. Section V concludes the article.

THE PROBLEM OF THE LOCAL COMMUNITY

Let us assume that N households live in and around a protected forest. We assume that out of N households, only n are engaged in forest resource extraction. We begin our model by analyzing the economic activity representative of the n households. N-n households do not extract forest resource because their agricultural income is higher or the opportunity cost of their time is higher.

Households are involved in two different production activities: agricultural production and illegal extraction of forest resources. Therefore, equation (1) gives the total benefit of the representative household. The first term $P_a\mathrm{Q}$ represents benefits due to agricultural production, where Q is the agricultural output and P_a is its given unit price. The second term $P_T\mathrm{H}$ is the benefits from forest extraction, where H is the harvest of forest resource (say, timber) and P_T is its price.

$$U = P_a\mathrm{Q}(L_a) + P_T\,\mathrm{H}\,(L_H) \tag{1}$$

We assume that both Q and H are concave and twice differentiable functions of labor time L_a, and L_H for Q and H respectively. Equation (2) is the resource constraint of the household; i.e., total labor time M is the sum of the effort used in the two production activities.

$$L_a + L_H = M \tag{2}$$

Equations (1) and (2) give a well-defined allocation problem. It is obvious that there exists a trade-off between these two. However, the allocation of effort is influenced by the fact that forest resource extraction in a protected forest is illegal. Harvesting forest resources involves the cost of illegal harvesting. People may be caught by forest guards and fined. The fine is supposed to be fixed by existing Forest Law, while the probability of being detected, v, is assumed to be function of policing cost NC_p, where C_p is the per unit policing cost by the forest authority and NC_p is the total cost and the time spent on illegal activity L_H. The cost structure is so because, given the greater accessibility, the larger the forest size, the larger will be number of households surrounding the forest and the larger will be the cost of policing.

$$v = v(NC_p, \mathrm{L_H}) \tag{3}$$

where $v(NC_p\ 0) = 0$ and $v(0, L_H) = 0$.

If the fine is denoted by D, the expected benefit will be $(1 - v)\ U + v\ (U - D)$. A representative household, therefore, takes the policing cost C_p as given while deciding as to their harvesting activity. Assuming the household to be risk-neutral, a household maximizes expected benefit

$$(1 - v)\ U + v\ (U - D) = P_a\mathrm{Q}(L_a) + P_I\mathrm{H}(L_H) - Dv\ (NC_p, \mathrm{L_H})$$

by choosing L_H. Since total time M of the household is fixed, the choice of L_H determines L_a.

Assuming interior solution[1] F.O.C. of maximization is:

$$P_a\mathrm{Q}_{La}(L_a) = P_T\ H_{LH}(L_H) - Dv_{LH}\ (NC_p, L_H) \tag{4}$$

Equation (4) implies that value marginal productivity of labor time in agriculture is equal to the expected value marginal productivity of labor time in forest extraction. Figure 1 depicts the allocation of labor time between the two production activities of the household. The figure shows $\hat{L}_H$ as the optimum harvesting time.

Given marginal harvest function, a rise in P_a, or a shift in Q_{La} reduces forest-harvesting time and increases agricultural time. Similarly for a given value marginal productivity in agriculture. an increase in D or v_{LH}, shifts down the marginal harvest function and harvest time $\hat{L}_H$ will he reduced, and consequently

$$\hat{H} = H\ (\hat{L}_H\ ) \tag{5}$$

the harvest of forest resource, will fall. We will assume that individual household extracts $\hat{H}$ amount of forest goods and analyze in the rest of the article accordingly.

[1] This structure of illegal activity has close resemblance with Skonhoft and Solstad [14]. The context was wildlife poaching by local people where the marginal condition for poaching effort and agricultural effort becomes $G_N \geq bf_L - Q\theta_L$. The LHS is the marginal productivity of labor time in agriculture and the RHS is the marginal productivity of poaching activity less the associated cost. When $G_N \succ bf_L - Q\theta_L$, poaching is nil and all efforts are engaged in agriculture and when $G_N = bf_L - Q\theta_L$ an interior solution occurs. By similar reasoning we assume that our $N - n$ households who do not extract forest resource have the condition $P_aQ_{La}\ (L_a) \succ P_TH_{LH}\ (L_H) - Dv_L\ \ (NC_p,L_H)$. However, for a positive L_H, the equilibrium condition is: $P_aQ_{La}\ (L_a) = P_TH_{LH}\ (L_H) - Dv_{LH}\ (NC_p,L_H)$.

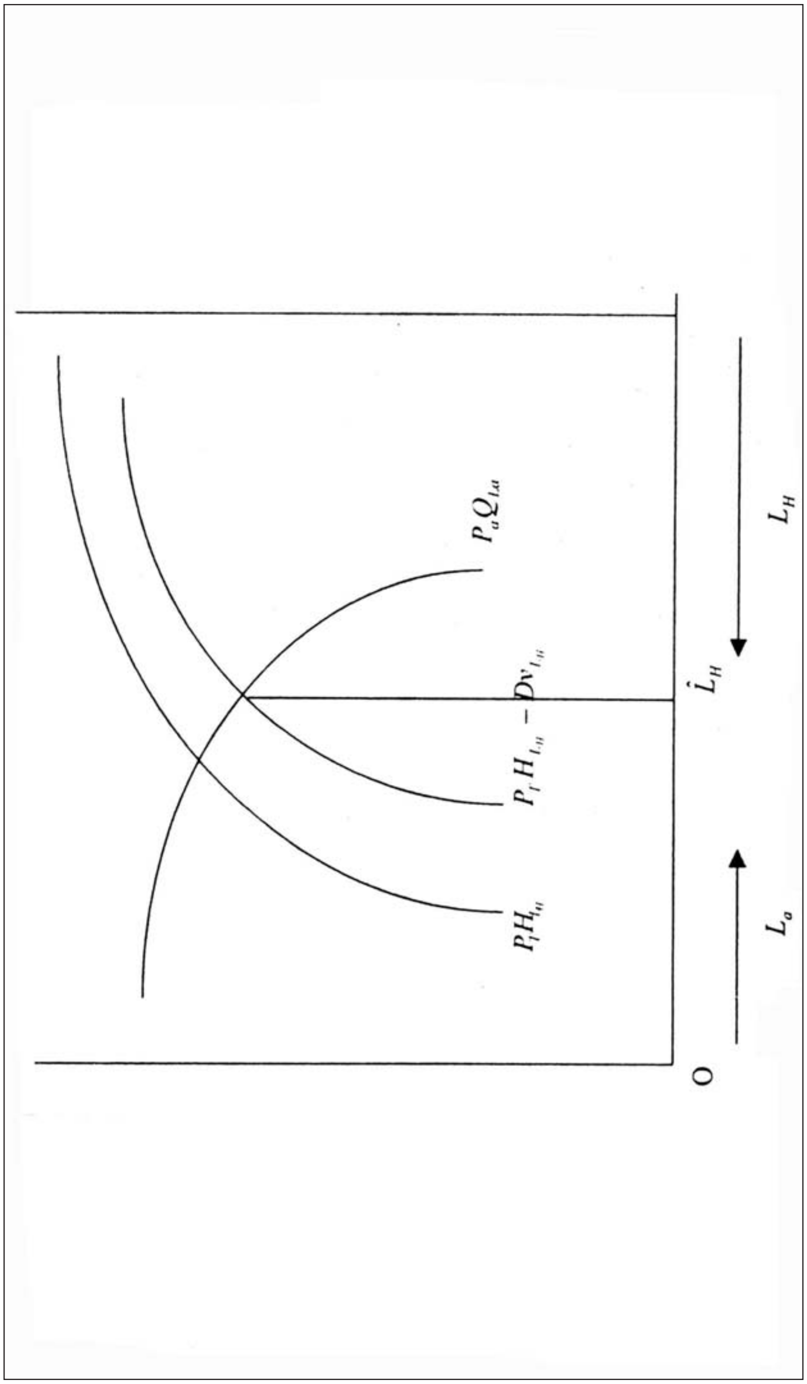

Figure 1. Equilibrium labor allocation between agriculture and forest extraction.

FORESTER'S PROBLEM

The dominant literature on forest extraction focuses on the optimal cutting time [15]. We depart from that. The forester in our model, however, wants to maximize static net benefit from the sale of timber (say).

Let an inverse demand function

$$P_G = a - bq_G,\ a > 0, b > 0 \tag{6}$$

exists for forest goods (timber) q_G. (Timber has the most damaging impact on forest—see Table 2.) So, the standard demand function can be written as

$$q_G = \frac{a}{b} - \frac{P_G}{b} \tag{7}$$

As discussed in Section II, N households surround the forest. The forest authority has to prevent them from extracting the forest illegally with an administratively given cost.

Recalling equation (5), each household extracts $\hat{H}$ amount of timber. We have assumed that out of N households, only n households are actually engaged in illegal felling. Therefore, total illegal extraction is $n\hat{H}$, n households receive $n\ (P_T\hat{H} - D_v)$ from the sale of forest extraction. The amount received by the n households inflicts loss to the forester's net benefit. In fact the monetary loss is more than what is earned by illegal extractors, because illegal extractors sell timber at illegal market prices where timber is under-priced. But forester's could have received the market price for that timber had there been no illegal felling Thus, the actual loss to the forester for $n\hat{H}$ unit of timber is $\hat{P}_G n\hat{H}$, where $\hat{P}_G$ is the market price for timber and since illegal price P_T is less than market price $\hat{P}_G > P_T$.

Due to illegal felling the formal market demand for forest goods will be a residual demand and not as in Equation (7) because a part of the demand will be met from the illegal market. In fact it will be reduced by the amount of illegal felling $n\hat{H}$. Therefore, in the presence of illegal felling, the demand function for forest good faced by a forester is

$$q_G = \frac{a}{b} - \frac{P_G}{b} - n\hat{H} \tag{8}$$

or, the inverse demand function will be

$$P_G = A - bq_G \tag{9}$$

where

$$A = a - bn\hat{H} \tag{10}$$

Since $a > 0, b > 0$, therefore, $a > A$.

Thus, the net benefit of the forester under illegal felling is

$$\pi_F = (A - bq_G)q_G - C_h q_{G - CpN} - en\hat{H} \tag{11}$$

The first term in the R.H.S. in equation (11) is the total revenue, the second is the forester's harvesting cost, the third is the policing cost and the last term is the ecological loss[2] of forest associated with illegal felling. Since we do not know the exact ecological loss, we assume that e is the ecological loss per unit of illegally felled timber. So for a total illegal extraction $n\hat{H}$, the ecological loss is $en\hat{H}$.

The forester now maximizes his net benefit in (11) by choosing q_G. The equilibrium quantity, price, and net benefit of the forester are given respectively by

$$\hat{q}_G = \frac{A - C_h}{2b} \tag{12}$$

$$\hat{P}_G = \frac{A + C_h}{2} \tag{13}$$

$$\hat{\pi}_G = \frac{(A - C_h)^2}{4b} - C_p N - en\hat{H} \tag{14}$$

Having found the equilibrium output, price, net benefit in presence of illegal felling, we will see what happens to these quantities of output, price, and net benefit of the forester if the illegal felling of timber can be restrained. We will see on the following pages what happens to these through the participation of stakeholder community in the management of forest. We elaborate below this concept of "Participation" and how it may be implemented.

THE FORESTER'S PROBLEM: THE COMMUNITY AS A CO-SHARER

In recent years, approaches to forest management and biodiversity conservation have shifted fundamentally from a focus on centralized planning and management by government agencies to a more participatory approach that balances social, environmental, and economic objectives. So our forester takes initiatives to arrive at an understanding with the people living in the vicinity of the forest so that households themselves desist from extracting the forest resources illegally. In return, the households would, say, get an equal amount of compensation by involving themselves in alternative economic activities like poultry,

[2] Illegal extraction of forest resource involves ecological loss, which diminishes the net benefit of the forester. Why illegal extraction creates ecological loss to the forest is discussed in the Empirical Part.

dairy, or pisciculture run by the forester. These activities, popularly known as Eco-Development Planning in the context of forest management, are run under the leadership of the forest authority with the active participation of stakeholders. People agreeing to this understanding become members of the Forest Protection Committee and therefore the forester can save on policing and ecological cost.

Suppose the households who were previously engaged in illegal felling of timber are persuaded to stop such felling. Also suppose that in return they would get what they used to earn by felling timber illegally from the forest and selling it at illegal market prices. The forester ensures the compensation package to the households by involving them in cutting and felling trees when the forester wants to harvest timber. One of the activities of the FPC members is to police the forest and cooperate among themselves and with forest authorities in conserving the forest. Since the households live in and around the forest, their mere presence ensures to some extent such policing, provided they may be made an integral part of forest management. Thus a participatory rather than an exclusionist approach is followed in such conservation process. Households, after their own income is duly compensated by forester, are turned from exploiters to conservators of forest.

The *modus operandi* of patrolling the forest and imposing penalties may not be so effective because the C_{pN} policing cost tends to make the probability of detection equal to v and so long as $v < 1$ households could make a positive expected benefit from forest extraction. Therefore, it can be assumed that v, the probability of detection that NC_p amount of policing cost can generate, is not sufficient to stop illegal felling. To stop illegal felling totally, probability of detection has to be made one for any positive level of L_H, and for that to occur, the policing cost might become so high that the forest might not be worth preserving. To circumvent this possibility there may occur a change in scenario in the context of forest management: a change from an exclusionist approach to a participatory approach.

Possible Consequences of the Changed Scenario

The changed scenario is likely to have the following consequences:

- If all the n illegal extractors for whom the per-unit policing cost is C_p, could be persuaded to participate in the understanding and join the Forest Protection Committee, then the cost of policing would reduce by nC_p.
- Forest products of amount $n\hat{H}$ will now be in the forester's possession. The n households in total receive $nP_T\hat{H}$ as compensation. The compensation package gives the local community alternative earning opportunities in dairy development, pisciculture (etc.) under the overall supervision of the forester. Households in return are required to surrender their illegal harvesting time to these alternatives.

- Ecological loss to the extent of $en\hat{H}$ will be avoided.
- A household's income does not decline from this shift of scenario but now there will be a qualitative change in income. Earlier it was illegal income but now it is legal income. This qualitative change in income may have quantitative attribute in rural isolated community. Illegal income has some social stigma. In rural life, such people are sometimes ostracized socially and economically, i.e., they may be debarred from government work programs like Jowahar Rozgar Yozana or Food for Work.
- The demand for legal forest goods will increase at each legal price following the non-availability of illegal forest products. As a result, demand for forest goods will increase by the amount $n\hat{H}$.

Adding $n\hat{H}$ to the demand function in Equation (4.3), we get $q_G = \frac{a}{b} - \frac{P_G}{b}$, or, the corresponding inverse demand function is $P_G = a - bq_G$.

Using $P_G = a - bq_G$, and the effects of changed scenario (Forest Protection Committee, Eco-Development Program), the net benefit function of the forester can be written as

$$\pi_G = (a - bq_G)q_G - C_h q_G - C_p(N - n) - P_T n\hat{H} \tag{15}$$

Maximization of Equation (15) with respect to q_G gives the optimum quantity, price, and net benefit of the forester respectively

$$\hat{\hat{q}}_G = \frac{a - C_h}{2b} \tag{16}$$

$$\hat{\hat{P}}_G = \frac{a + C_h}{2} \tag{17}$$

$$\hat{\hat{\pi}}_G = \frac{a - Ch)^2}{4b} - C_p(N - n) - \hat{P}_T n\hat{H} \tag{18}$$

Subtracting (14) from (18) to get the outcome of the change in scenario we get,

$$\hat{\hat{\pi}}_G - \hat{\pi}_G = \frac{(a - C_h)^2 - (A - C_h)^2}{4b} + C_p n + - \hat{P}_T n\hat{H} + en\hat{H} \tag{19}$$

$$\hat{\hat{\pi}}_G - \hat{\pi}_G = (\hat{P}_G - \hat{P}_T)n\hat{H} + \frac{(bnH)^2}{4b} + C_p n + en\hat{H} - C_h n\hat{H} \tag{20}$$

(see Appendix for details.)

Since under the changed scenario, households can also be employed to harvest timber under the guidance of the forester, the harvesting cost $C_h n\hat{H}$ does not exist for the harvester. Households will harvest $n\hat{H}$ unit of timber, this time under the guidance of the forester. With silvicultural practices adopted by the forester, it is expected that there will be no ecological loss and the forester therefore need not bear that cost.

It follows that the forester's net benefit from engaging community in the management of the forest will be

$$\hat{\hat{\pi}}_G - \hat{\pi}_G = (\hat{P}_G - \hat{P}_T)n\hat{H} + \frac{(bnH)^2}{4b} + C_p n + en\hat{H} \quad (21)$$

Now, since market price is greater than illegal price $\hat{P}_G > \hat{P}_T$, the term in Equation (21) yields a positive value. The first term is the benefit to the forester when the forester could have sold the timber at market price instead of households' selling it at illegal price. The second term is the benefit from increased monopoly power over the timber market, because $\frac{(bn\hat{H})^2}{4b} = (\hat{\hat{P}}_G - \hat{P}_G)(\hat{\hat{q}}_G - \hat{q}_G)$ (see Appendix). The third term is the savings on policing cost, the fourth is the benefit in terms of ecological loss.

Empirical Estimation

For empirical estimation of some of the benefits of community participation, a survey was conducted in the Buxa Tiger Reserve in the district of Jalpaiguri, West Bengal, India. We have estimated the first component of the benefits $[(\hat{P}_G - \hat{P}_T)n\hat{H}]$ in Equation (21), which we call economic loss in the absence of community participation or economic benefit had there been community participation. We have also given a proxy or indirect estimation of ecological loss due to illegal felling.

Description of the Survey Methodology

The data used for the estimation purposes were collected from four villages. Cheko, Nimati, Raimatang, and Satkodali, in and around the Reserve. The Reserve covers an area of 760.87 sq. kilometers. According to the 1991 Census, 15,608 people inhabit the forest villages, and another 84,648 people surround the Project area [16]. Besides collecting timber and fuelwood, local people also collect a wide variety of non-timber forest products (NTFP), like thatch, small poles, fruits, bamboo, fencing materials, and decorative, medicinal, and edible plants. The households themselves use some of the fuelwood and NTFP items and some are sold locally (see Table 1). A total of 165 households (N), about 50% of total households of each village, were personally interviewed through a questionnaire. Households were selected randomly from the list available with the local Panchayats (lowest level of rural local self-government). Information about the quantities $\hat{H}$ (both sold and used) and prices P_T was collected. Information about market prices ($\hat{P}_G$) was collected from the forest officials and local markets. Out of the total 165 households, 152 (n) were found to be dependent on forest in some way or other.

Economic Loss

Failure to involve community in forest conservation as discussed in section 3 carrier both economic and ecological loss. There are FPC members in the villages, but very little EDP activities. FPC members, therefore, don't get the motivation of protecting the forest and were found to be extracting forest resources. As discussed in section 3, $n\hat{H}(\hat{P}_G - \hat{P}_T)$ is a part of the benefit of the forester from community participation. Log- and pole-fall is not allowed to be extracted. The difference between market price and the price at which illegal forest goods are sold times their quantity is the amount of loss to the forester due to illegal extraction (see Table 1).

Table 1 shows that households also extract many non-timber forest products like fruits, medicinal plant, and fencil material. Since they are small in quantity and the forest authority normally does not object, we rule out such extraction from our theoretical exercise in section 2.

Estimation of Ecological Loss

While foresters follow botanical guidelines while extracting forest resources, illegal extraction is unlikely to have such care. The ecological system is a complex

Table 1. Average Annual Dependence on Forest Resources ($N = 165$, $n = 152$)

Forest resources	Sold at price (Rs) P_T	Quantity $\hat{H}$	Market price (Rs) $\hat{P}_G$
Fuelwood (own use)		2844.19 kg	1.5 per kg.
I) Log	5,000/per piece (appx)	52 pieces	8000/per piece (appx)
ii) Pole	500/per piece	577 pieces	1000/per piece
I) Thatch	5/per bundle	1555 bundles	9/per bundle
ii) Fruit	10/per kg.	108 kg.	20/per kg.
iii) Medicinal plants	20/per kg.	96 kg.	35/per kg.
iv) Small pole	10/per piece	340 pieces	30/per piece
v) Decorative (Mat)	—	—	—
vi) Fencing material (Small Bamboo)	5/piece	1345 pieces	8/per piece

Source: Own Survey at Buxa Tiger Reserve, 2003.

one and maintaining ecological equilibrium deserves utmost planning and deep knowledge of forest habitat. Illiterate or semi-literate poor people who surround the forest in a developing economy like India, possess neither and the maintenance of the ecological system is not on their agenda. Thus, the entire food pyramid of wildlife living in such a forest gets disturbed as a result of such high discount rate of the illegal extractors. The wildlife of the forest is unable to find adequate food within the forest and, therefore, encroach upon the private crop field causing monetary loss to the villagers [17]. In the survey area, such man-animal conflict is a regular incident also culminating in the loss of human life (see Table 2).

It is true that illegal extraction of forest resources involves some ecological loss, but it is difficult to quantify such loss. This requires botanical surveys before and after the extraction, and assessment of the implications for forest ecology. However, following Stork et al. [18], we can qualitatively comment on some of the impacts of human intervention on forest ecology (see Table 2).

While the full explanation of this table is beyond the scope of this article, it is clear that logging has an impact on all seven indicators. Any intervention has some impact on habitat diversity. Let us discuss some of the aspects of Table 2 which we think will be important in this context. A large X implies a major impact, and a small x implies small impacts on the forest. Selective logging is the most common form of intervention in tropical forests. It also includes “pole removal” of understory trees for building material. The collection of non-timber forest products (NTFPs) is also very common [19]. Reproductive NTFPs (fruits, nuts, seeds, flowers), non-reproductive structures (bark, latex branches for firewood, foliage) and whole individuals (ornamentals, hunting, fishing) are distinguished. Human-induced changes in forests can produce landscape-level changes in forest characteristics and structure, including area and habitat types. Changes in landscape pattern through fragmentation and aggregation of habitats can alter patterns of abundance for single species and entire communities [20-24]. Habitat fragmentation is recognized as a threat to biodiversity [25, 26]. Such impacts on biodiversity of the reserve can be understood by looking at the tiger population of the Reserve. In 1984, the Reserve had a tiger population of 15. In 1989 it grew to 33. In 1995 it came down to 31 [16]. The tiger population continues to decline [16].

There is an intimate relationship between species and their habitats. For this reason, habitat diversity is potentially a powerful indirect indicator of species diversity [27]. The great structural and resource heterogeneity provided by plants is the principal reason for the high animal diversity in tropical forests [28, p. 563]. High habitat diversity contributes to small animal diversity in forests [29], but for larger, more mobile animals, physical heterogeneity of the forest is less important for maintaining diversity than the productivity of their food resource [30, 31]. For example, in the Buxa Tiger Reserve, the villagers are feeling the symptom of food scarcity for elephants, who often come out of the

Table 2. Consequences of Human Intervention on Forest

Intervention indicator	Landscape pattern	Habitat diversity	Guild structure	Taxic richness	Population structure	Nutrient cycling decomposition	Water quality and quantity
Selective logging	x	x	x	x	X	x	x
Grazing		x		x	X		
Fire		x	x	x	X		
NTFP: reproductive structures		x			X		
NTFP: non-reproductive structures		x			X		
NTFP: whole individual		x			X		
Other land use: agriculture	x	x	x		X	x	x
Other land use: plantations	x	x	x		X	x	x
Other land use: road	x	x	x				

Source: [18]

forest and damage crops. As a result man-animal conflict in the study area is almost a daily incident. The conflict sometimes culminates in injury or death of human lives also (see Table 3).

The Forest Department has to compensate for such damage though the villagers, as revealed in the survey, are never satisfied with the amount of compensation. The Forest Department, however, has its own explanation. Foresters allege that villagers over-report the actual amount of damage done by wildlife. Nonetheless, we can say that whatever is given as compensation is a loss to the forester and this loss is due to the ecological imbalance of the forest created by illegal extraction. The amount of compensation by the Buxa Tiger Reserve Authority in 1996-97, 1997-98, 1998-99, and 1999-2000 were respectively (Rs. 000) 337,509,662 and 752 [16]. The amount of compensation for the damage caused by wildlife is, therefore, a proxy estimate of ecological loss on the assumption that the forester's own intervention does not in any way disturb the forest ecology or biodiversity. Since the foresters' own extraction of forest resources takes place under the guidance of trained, well-versed forest personnel and they follow botanical planning, it can be assumed that such ecological loss is a consequence of illegal felling only.

CONCLUSION

Historically, forests in India were owned and managed by local communities in and around the forest. Communities themselves evolved rules and norms which ensured the sustainable use of forest. But in developing countries, forest and conservation policies have traditionally been characterized by general distrust of local people's ability to manage the forest on which they depend. Governments have nationalized forests and established protected areas in order to ensure the benefits of forests and protect the wildlife habitats from human utilization. However, state-ownership and management have not been very successful in preventing forest degradation.

Community participation enhances profit of the forester more than the legal and punitive measures do. Both forester and stakeholders benefit through this

Table 3. Statistics of Man-Animal Conflict,
Buxa Tiger Reserve

	1996		1997		1998		1999		2000	
	Death	Injury	Death	Injury	Death	Injury	Death	Injury	Death	Injury
Elephant	7	4	3	3	6	2	3	4	4	2
Leopard	0	4	1	4	0	4	0	3	0	4

Source: [16]

approach to forest conservation. The forester then can spend the additional profit on conservation effort.

However, the success of community participation does not appear to be unconditional. Engaging poor semi-literate local communities in alternative employment like poultry, dairy, and pisciculture may incur considerable costs. People might not be efficient enough in the new occupation and forest officials may also lack required skill and incentive to monitor these alternative employment activities on top of their routine work. In that case the compensation flow will be terminated because foresters would not be able to generate enough profit to compensate the stakeholders on a regular basis.

However, helping people to develop skills in their new occupation will have a long run benefit for the forest. Gradually, dependence on the forest by these people will be lessened.

Despite the above criticism, community participation appears to be an effective forest conservation policy. As we have seen, the forester has to increase the probability of catching timber poachers or the cost after they are caught. While the former requires increased patrolling of the forests, for which the cost may exceed the benefit from the forest, the latter must be socially acceptable. Thus legal and punitive measures have some weaknesses in the context of forest management.

Generally speaking, a participatory rather than an exclusionist approach is the need of the hour in forest management. Refusing the local communities' traditional rights altogether would make the forester poorer by the amount incurred in terms of policing cost, reduction in demand for forest goods (timber), and ecological loss to the forest. We can conclude that popular participation in the forest conservation process is inherently superior to the legal and punitive regime.

APPENDIX

A.4.1

From 4.14,

$$\Delta\hat{\hat{\pi}}_G = \hat{\hat{\pi}}_G - \hat{\pi}_G = \frac{(a - C_h)^2}{4b} - \frac{(A - C_h)^2}{4b} + C_p n + en\hat{H} - P_T n\hat{H}$$

$$= \frac{(A - C_h + bn\hat{H})^2 - (A - C_h)^2}{4b} + C_p n + en\hat{H} - P_T n\hat{H},$$

since $a = A + nb\hat{H}$

$$= \frac{(A - C_h)^2 + 2(A - C_h)bn\hat{H} + (bn\hat{H})^2 - (A - C_h)^2}{4b} + C_p n + en\hat{H} - P_T n\hat{H}$$

$$=\frac{2(A-C_h)bn\hat{H}+(bn\hat{H})^2}{4b}+C_p n+en\hat{H}-P_T n\hat{H}$$

$$=\frac{(A-C_h)n\hat{H}}{2}+\frac{(bn\hat{H})^2}{4b}+C_p n+en\hat{H}-P_T n\hat{H}$$

$$=\left[\frac{(A+C_h)}{2}-C_h\right]n\hat{H}+\frac{(bn\hat{H})^2}{4b}+C_p n+en\hat{H}-P_T n\hat{H}$$

$$=\left[\frac{(A+C_h)}{2}n\hat{H}\right]-C_h n\hat{H}+\frac{(bn\hat{H})^2}{4b}+C_p n+en\hat{H}-P_T n\hat{H}$$

$$=[\hat{P}_G n\hat{H}-P_T n\hat{H}]-C_h n\hat{H}+\frac{(bn\hat{H})^2}{4b}+C_p n+en\hat{H}$$

$$=(\hat{P}_G-P_T)n\hat{H}+\frac{(bnH)^2}{4b}+C_p n+en\hat{H}-C_h n\hat{H}$$

A.4.2

$$(\hat{\hat{P}}_G-\hat{P}_G)(\hat{\hat{q}}_G-\hat{q}_G)=\left[\left(\frac{a+C_h}{2}\right)-\left(\frac{A+C_h}{2}\right)\right]\left[\left(\frac{a-C_h}{2b}\right)-\left(\frac{A-C_h}{2b}\right)\right]$$

$$=\left(\frac{a-A}{2}\right)\left(\frac{a-A}{2b}\right)$$

$$=\left[\frac{A+bn\hat{H}-A}{2}\right]\left[\frac{A+bn\hat{H}-A}{2b}\right]$$

$$=\frac{(bn\hat{H})^2}{4b}$$

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