A second look at the economics of natural management systems in tropical mixed forests

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INTEGRATED WATERSHED MANAGEMENT IN THAILAND the economics are better than they appear

• Some years ago I attempted an assessment of the economic possibilities of natural management in the tropical moist forests (Leslie, 1977). It was, I now realize, unduly pessimistic on at least two counts.

First, it exaggerated the extent to which ecological complexity caused natural management to fail and enthusiasm for it to evaporate. There is no doubt that the most common and prominent feature of tropical forest management is the limited success of natural management systems. More often than not, this lack of success is the result of no management at all, rather than the failure of natural management. However, there are enough examples of success with natural management systems for it to be quite clear that technical difficulties are rarely the principal or even significant factors in the failure of management. Enough is known of the ecology of many different tropical forest types for them to be kept in permanent timber production management without destroying their natural structure. Indeed, as Jabil (1983) has pointed out, the lowland dipterocarp forests of Peninsular Malaysia, managed under the Malaysian Uniform System, would by now be providing second rotation yields had they not been cleared for agricultural development.

Second, my conclusion of about a decade ago was incomplete. Natural management is worth pursuing not simply, as I then felt, because of what might be lost if the economic case against it were wrong. At the same time, I suspected that there was something wrong with the economic argument by which natural management was so easily dismissed, and that this something was more than its reliance on the doubtful economics of timber production and other revenue-earning outputs. I now realize that the missing something is a combination of many serious flaws in both the underlying economic theory (Leslie, 1983) and its application in practice. More important, there is now increasing certainty that there is a much stronger economic case in *favour* of natural forest management.

The main purpose of this article, therefore, is to outline the argument through which I have come to that near reversal of a conclusion. Since it is an extension of the 1977 and 1983 papers referred to, I will not repeat their arguments. Rather I will concentrate on the broader and deeper aspects of economic analysis which another ten years have revealed.

Conservation of the tropical forests by management

The conservation of the tropical moist forests could well be, as many conservationists argue, the crucial conservation issue of our time. Mere concern, however, will not lead to conservation. Whatever cures a superficial examination of the visible causes of tropical deforestation might suggest, the underlying reason, as Westoby (1982) so clearly shows, is the extent and depth of poverty in the Third World. Unless that poverty is overcome, the chances of conserving much of the tropical moist forest - by talk, by exhortation, by research or even by directives - are negligible. Unfortunately, present attitudes are not disposed to acknowledge any international responsibility for Third World poverty, and present methods for distributing the trivial amounts of conscience money now devoted to the problem combine with the vested interests opposed to any real change to guarantee Third World poverty a permanent place in the world economy.

Given that, the tropical moist forest can survive only if the land itself is seen by the people concerned to be more valuable retained as forest than converted to any other form of land use. The key to convincing people that forests are worth preserving is industrial utilization of the tropical moist forest under sustained yield management. Contradictory though this may sound to those who see logging as the principal cause of deforestation, there is, under present conditions, no other way.

The conservation of the tropical mixed forest depends largely on the possibility and feasibility of managing it as a sustainable system, maintaining, for the most part, the components of the original ecosystem (Catinot, 1974) through natural regeneration, while providing, at the same time, the raw material supply for a large-scale, rurally located, viable forest products industry.

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The key to convincing people that forests are worth preserving is industrial utilization of the tropical moist forest under sustained yield management.

It is a very tall order. After all, the conditions which have to be met for natural management to be effective (FAO, 1985a) are quite demanding. It must be:

- ecologically and technically possible;
- economically feasible and attractive; and
- socially and politically practicable.

This article is concerned with the second of those conditions: economic feasibility and attractiveness. This presupposes, of course, that the first condition can be met. In the Asian-Pacific region at least, it *is* generally being met with several forest types. Undoubtedly natural management is not so widely nor so well practiced as it ought to be, but the reasons for that are more economic than ecological. And they are probably as exaggerated as the ecological difficulties once were.

The economic case against natural management

It is deceptively simple to show that natural management of the tropical mixed forest is not economic. According to the information summarized and evaluated by Masson (1983), tropical mixed forest under natural management seems to require a rotation of 60 years or more to produce a final commercial mean annual increment (M.A.I.) of 0.5 to 2.0 m^3/ha. The silvicultural costs associated with establishing the naturally managed forest range from US$20 to $100/ha. Although not reported by Masson, recurring costs of administration and management would appear to run between $0.5 and $1.5/ha annually.

Judging from the range of stumpage prices for tropical non-coniferous timbers reported in FAO

(1985a), \$20/m^3 would be a generous estimate of the average rate, with perhaps \$6/m^3 as a realistic lower bound.

From those estimates, the extremes of revenue and cost on a 60 year rotation would be:

Highest revenue:

M.A.I. 2.0 m^3/ha
Stumpage \$20/m^3

Lowest revenue:

M.A.I. 0.5 m^3/ha
Stumpage \$6/m^3

Highest cost:

Establishment cost \$100/ha
Recurrent costs \$1.5/ha/yr

Lowest cost:

Establishment cost \$20/ha
Recurrent costs \$0.5/ha/yr

The corresponding benefit-cost ratios at various discount rates are summarized in Table 1.

Table 1. Indicative benefit-cost ratios for tropical moist forest under natural management over a range of discount rates

	Discount rate (%)											
	0	2	4	6	8	10	0	2	4	6	8	10
	Highest revenue						Lowest revenue					
Highest cost	12.6	4.9	1.7	0.6	0.2	0.1	0.95	0.36	0.13	0.04	0.02	0.01
Lowest cost	30.5	19.5	7.0	2.5	0.8	0.4	2.25	0.82	0.28	0.10	0.03	0.01

Source: Estimates above from Masson (1983) and FAO (1985)

From this Table it can be seen that the expected returns, or benefits, from natural management in the tropical moist forest are likely to cover the costs involved only when:

- growth rates and stumpage prices are close to the maximum possible;
- silvicultural and management costs are close to the minimum possible; or
- the discount rate is well below those that are commonly applied, recommended or required in investment appraisals.

It is no wonder then that natural management is so often dismissed on economic grounds. Rarely could it be realistically expected that the peak performance levels needed to make it economic would be achieved and maintained in practice.

This example is, of course, an extremely simplified version of the standard demonstration, but

even more sophisticated treatments differ little in principle. The productivity of the tropical mixed forest under natural management would seem therefore to be too low to be economically viable. This conclusion does indeed have an air of plausibility. Since natural management is very intensive in both its land and capital requirements (Masson, 1983); and since both of these are, almost by definition, in short supply in developing countries, it would seem uneconomic and even irresponsible to lock up large amounts in such a low output activity.

This economic case against natural management, as made above, would therefore be almost unanswerable but for one thing: it is almost entirely wrong.

Glossary of terms used in this article

Benefit-cost ratio: the total economic returns, or benefits, likely to accrue from the implementation of a given project or activity as compared to the costs for undertaking that same activity. A ratio of benefits divided by costs of greater than 1.0 indicates that benefits outweigh costs; a ratio below 1.0 means that costs exceed benefits; a ratio of 1.0 indicates that they are equal.

Discount rare: the rate of interest at which the values of benefits and costs occurring at various future dates are transferred to present value equivalents.

Faustmann formula: a formula for calculating the present (discounted) net value per hectare of the stream of costs incurred and revenues accrued over an infinite series of Umber rotations.

Shadow (accounting) prices: non-market prices applied to labour, capital, imported goods, etc. to achieve a more rational valuation and allocation of scarce resources: in a developing country, for instance, a vast shortage of tractors might cause the market price of tractors to be astronomically high, but the application of shadow prices can bring it within reach of potential consumers. The goal of applying shadow, or "accounting", prices is often to spur economic growth.

The weakness of the economic case against natural management

One respect in which the case against natural management is wrong is self-evident: it is far too incomplete. It omits many benefits either because they do not earn revenue or are external to the administering agency for forestry. Evaluation in terms of commercial timber production alone may be a legitimate procedure from the point of view of an individual or corporate forest-owner whose sole interest or responsibility is the financial profitability of timber. But very little of the tropical moist forest fits into this category. Most of it, in fact, is under some form of public or communal ownership. The inadequacies of purely financial appraisals of public investments are so well documented (Gregerson and Contreras, 1979) that further comment would be superfluous. The distinction between a financial appraisal which excludes non-revenue producing benefits and external effects, and the true economic appraisal which includes them is now well-recognized. Moreover, in social benefit-cost analysis, a well-established and quite advanced technique exists for making the step from financial to economic appraisal.

Economic appraisal does more than correct for the omissions. It also substitutes social values for market values where there are grounds for believing the two are substantially different. Moreover, it widens the scope of the analysis well beyond the view of the agency directly responsible. These extensions, however, involve very great theoretical and practical difficulties. In spite of the advances that have been made in the techniques of social valuation (Sinden and Worrell, 1979) some of the difficulties can still be resolved only in quite arbitrary ways. One of these - the discount rate - is alone almost enough to undermine the standard economic formulation applied to forestry.

Before turning to that issue, I should mention two points of theory on which the standard evaluation, even in its most comprehensive form, is on rather weak ground. One is the

awkward fact in temperate forestry management that, despite all the economic analysis and preaching over the century or more since the "Faustmann Formula" was finalized, it has had very little influence on forest management and policy in practice. Similarly, in tropical forestry, natural management systems are still attempted despite their alleged economic non-viability.

That alone should raise doubts. Economics, at its best, is supposed to explain economic activity. To say that something should not be done when it so clearly *is* being done - and, in fact, is preferred - is hardly an explanation. Something must be wrong when the facts do not fit the theory. Normally the theory would be suspect, but in economics, as many critics have pointed out (Seligman, 1962; Karmack, 1983), it is more often the facts that are judged to be wrong.

In practice, non-revenue considerations are in fact taken into account, so that the social benefit-cost ratio is accepted as being greater than 1. In principle, a formal benefit-cost appraisal should be able to confirm this. In practice it cannot. Too much arbitrary quantification of generalized concepts is still needed. It is perhaps better than nothing, but it is far from definitive. All the same, the fact that natural management is supported in practice may be better explained, in part at least, by the inclusion of the non-revenue-producing benefits and externalities associated with it than by disposing of it as an error.

To that can be added a second doubt, on theoretical grounds. This is the implied assumption that a Western individualistic view of rationality is universally valid. In fact, the assumption is almost entirely without foundation. As Myrdal (1972) puts it: "There isn't much point in analysing the economics of tropical forestry in terms of economic theory that may apply in developed countries but may not apply in developing countries." The trouble is that the economic system and the institutional and cultural systems are interdependent.

Unfortunately its weaknesses have not dislodged the neoclassical version from its implicit, self-professed standing as the only true economics. It retains this image by a powerful combination of:

- developing a body of theory whose cumulative intellectual brilliance and logical elegance divert attention from its irrelevance;
- ignoring criticisms or disarming them through subterfuges that twist contradictory evidence into confirmation, or dismissing dissenting views as belonging to special cases;
- monopolizing the teaching of economics and the staffing of economic policy institutions with people schooled in that tradition.

The possibility, of an economic appraisal of natural management

It is clearly not enough to demonstrate that the standard economic analysis is almost meaningless. The failure of the case against natural management in the tropical mixed forest does not establish the case for it. It has to be shown that natural management systems are:

- economically feasible in themselves; and/or
- they are better than any alternative use for the land and other resources involved.

The first step is to move from the basically financial appraisal underlying the standard evaluation to an appraisal of the economic one. This means bringing into the analysis all the non-revenue aspects and external effects, as Myers (1980) urges, plus looking at the results from a wider point of view than that of the administering agency. In addition, all inputs and

outputs should be expressed in monetary units at their social value.

Conceptually each step is logical and simple. In practice the operational difficulties are formidable. Three problems of special significance are worth mentioning: 1) the generality problem; 2) the boundary problem; and 3) the pricing problem.

The generality problem The expected financial results of forest management can be assessed in a general way, independently of forest type or location, without being entirely meaningless. The main financial effect of forest type and location is on stumpage prices. A range of likely average stumpage prices, such as that underlying the estimates summarized in Table 1, can be set wide enough to accommodate nearly all variations.

Such a generalized approach is much less tenable with an economic appraisal. Not only does the unpriced nature of the additional items preclude any sort of averaging, but many of them are also much more specifically related to forest type and location. For instance, the downstream importance of the hydrology of forested catchments will vary with topography and soils. The social value of forests on steep catchments with erodible soils is likely therefore to be higher than that of forests on easier topography with more stable soils. At the same time, however, the social value of a forested catchment depends on the nature, the extent and the value of the downstream interests which could be affected by the way the forest is managed. Both aspects have to be taken into account in an economic appraisal, and they are so type- and site-specific that any generalized approach must have only limited validity.

Similar difficulties arise with considering wildlife as an output of forest management. The type of forest and the wildlife for which it provides a habitat are closely linked, so that the social value of a tropical mixed forest is extremely type-specific. But the location of the forest relative to population centres and different socio-economic groups also governs the social value of its wildlife. People working agricultural land adjacent to a forest that harbours predatory or crop-destroying wildlife are likely to have a different view of its value than are people living in cities some distance away or hunter communities living in the forest. The forest ecosystem and its location could thus interact in too complex and too specific a way for any generalized economic appraisal to have much meaning.

These qualifications do not necessarily mean, however, that absolutely nothing can be gained from extending the generalized financial appraisal of Table 1 to an economic perspective. One thing which can usefully be done is to demonstrate what increases in returns would be needed to transform the benefit-cost ratios into ratios greater than 1. The values recalculated in this form are presented in Table 2. They indicate the amounts that would have to be credited annually for non-revenue-producing services to make the difference.

Table 2. Average annual value in US$ per ha on non-revenue-producing services required for benefit-cost ratio: [1]

	Discount rate (%)					
	0	**2**	**4**	**5**	**8**	**10**
Highest revenue/lowest cost	-39.2	-62.7	-77.6	-30.0	265.9	1439.2
Highest revenue/highest cost	-36.9	-54.7	-43.9	105.2	776.3	3271.4
Lowest revenue/lowest cost	0.2	9.2	54.4	242.5	955.7	3494.1
	-2.2	1.2	20.6	107.5	445.2	1661.9

Source: Table 1. *Note*: negative values indicate benefit-cost ratios >1 and positive values indicate ratios <1.

Since these are simply transformed versions of the benefit-cost calculations, negative values correspond to benefit-cost ratios greater than 1 in the financial appraisal and positive values to ratios less than 1. The lowest revenue/highest cost regime would thus be economically feasible if it were generally accepted that, at a discount rate of 4 percent, the total annual value of any relevant combination of services such as watershed protection, landscape, wildlife, gene pools, or yet to be discovered medicinal resources or conservation per se, is equivalent to about US$54/ha. At 10 percent the recognized and accepted annual value would have to be about US$3490/ha.

Again, no great reliance can be placed upon these actual figures, but they do bring out several important principles. The first is that, the higher the revenue from timber production and the lower the cost of management, the more easily the management system will be able to satisfy multiple objectives.

The second is the valuation of the relevant non-revenue services by a form of the consumers' surplus criterion. This means that if a natural management regime delivers a given combination of revenue and non-revenue services accepted as satisfactory, then the value placed on the non-revenue services must be at least equal to any loss incurred on the revenue-earning side. The criterion is not quite so simple as it suggests (Blaug, 1978) and it has had its ups and downs in economic theory. But these are of less concern to the economics of tropical forestry than are two awkward questions that its use raises or dodges: who accepts them and on what basis?

The boundary problem Both of these questions are derived from and compounded by the third principle, summarized in Table 2, which is that the net value to be assigned to or accepted for the non-revenue items depends very largely on the discount rate used in the benefit-cost calculations. It is here that the boundary problem comes in. For instance, there may be wide acceptance in Malaysia or Indonesia that management which protects the habitat of the orangutan or the white rhinoceros or other significant wildlife, together with watershed services, is worth an implied annual cost of $54/ha. That it is worth an implied cost of $3500/ha annually would be almost unanimously rejected. Yet conservationists and others in developed countries especially might well feel that protecting such species from extinction is well worth such a price.

From a global point of view the latter valuation could in fact be nearer to the truth. The trouble is that it involves extending the boundaries of the appraisal to cover the world. The near futility of this is obvious. Calls for the conservation of the tropical forests imply that specific developing countries should carry the management costs necessary to satisfy people, mainly in developed countries, for whom costs will occur only if and when species become extinct or ecosystems disappear. Such an unfair distribution of costs to the poor and benefits to the wealthy would have to be backed by an effective and adequate international system of transfer payments. There is no such system at present, nor is there any apparent intention to develop one. Without it, calls for the conservation of the world's tropical forests will, justifiably, continue to go unheeded. And without it, economic appraisal on a world scale is pointless.

However, economic appraisal of natural management in tropical mixed forests has to be extended at least to the national level. Despite technical difficulties, that is feasible. Extension beyond that boundary, although desirable and involving no greater technical difficulty, would, with a few regional exceptions, have no practical significance. Social values which are of primarily global concern would therefore be taken into account only to the extent that they would have an identifiable national impact.

This unfortunate fact of life simply confirms the point made at the outset. Under present conditions, the conservation of the tropical mixed forests in the interest of mankind as a whole

depends on natural management as being an economic proposition for each country which has forests. In that respect, the pricing problem, especially as it relates to the discount rate, is crucial.

This economic case against natural management would therefore be almost unanswerable but for one thing: it is almost entirely wrong.

Unfortunately its weaknesses have not dislodged the neoclassical version from its implicit, self-professed standing as the only true economics.

The pricing problem The third problem involved in the transition from financial to economic appraisal is that of expressing all the benefits and costs in social values. There are two aspects to this: first, the assessment of a social value for each revenue-affecting item wherever there are reasons for believing that it is not adequately represented by the market price; and second, the assignment of social values to the unpriced, hence non-revenue-affecting items.

The techniques of shadow or accounting prices for establishing social values usually concentrate on the first aspect: the adjustment of market prices. Logically the second aspect is no more than a special case of the accounting price problem with non-existent market prices. The point, however, is of little significance in a generalized appraisal of the economics of tropical forest management since it is only the total social value of an unspecified group of non-revenue items which, as argued earlier, has any relevance.

The idea behind accounting prices is that equilibrium market price in a perfectly competitive market and social value coincide. Therefore, in markets which depart widely from the perfectly competitive structure, it should be possible to estimate social value by calculating the price which would prevail if the market imperfections and distortions were removed. The substitution of accounting prices for actual prices would therefore be appropriate where wage rates were out of line with the actual labour supply or where the domestic prices for outputs or other inputs were held artificially high or low by protectionist policies or subsidies.

Imperfect markets with these and other similar distortions are as common in developing countries as they are in developed ones. An appraisal of the economics of tropical forest management calculated in accounting prices could be very different from one based on actual domestic prices. By how much it does can be gauged from recalculating the benefit-cost ratios of Table 1 in accounting prices. Suppose, for instance, the shadow wage rate is 75 percent of the legal rates paid by government and industrial forestry organizations, while labour accounts for two-thirds of the establishment and annual costs, and the accounting prices for timber are sufficiently higher to give socially valued stumpage rates 20 percent higher. The social costs and revenues would then have the following ranges:

- establishment from $17 to $83/ha
- annual maintenance and management from $0.40 to $1.25/ha/yr
- stumpage prices from $7 to $24/$m^3$.

Substituting these social values gives benefit-cost ratios running from 70.2 to 0.5 for the best possible outcome compared with 30.0 to 0.4 as the discount rate increases from 0 to 10 percent. For the worst possible case, the corresponding range of benefit-cost ratios is from 5.3 to 0.03, compared with 2.3 to 0.01. That is, the fact of substituting accounting prices for market prices lifts the benefit-cost ratios by a factor of two to three.

RAIN FOREST IN TAMIL NADU management is a means of saving it

Similar substantial improvements are naturally effected in the social values which would have

to be accredited to non-revenue items for natural management to break even. With the highest revenue/lowest cost combination, a positive value would have to be credited: if the discount rate were 10 percent, that would only be 25 percent of the amount needed under the financial appraisal with market prices. For the worst combination, positive social values would have to be credited for all positive discount rates, but at levels of 20 to 25 percent less than under the financial appraisal. Thus, at a 4 percent discount rate where the financial appraisal indicated that the social value of the non-revenue items would need to be about $54/ha/yr for natural management to break even, the corresponding figure under the economic appraisal would be about $42.

Correcting for market imperfections and distortions can clearly make a substantial improvement in the economics of natural management when imperfections keep market prices for inputs higher and output prices lower than their social values. Even so, it is still the discount rate which has the greatest influence in economic feasibility. Since it is the key variable in the economic - or even the financial - analysis of tropical forest management, it is worth a special section (if not a book) to itself.

Time and the rate of interest in natural management

As a general rule, fairly long, if not very rotations are required to grow forests to a state of maturity corresponding to the specifications of the goods and services expected of them. Time, therefore, is a major - and often *the* major - input in the forestry production process. During a rotation, a stream of recurrent and intermittent costs and receipts occurs; in anticipatory evaluations, many of these have to be taken for granted for years in advance. Forestry economics has to deal with three aspects of time in the production process:

- the *cost* of time as an input in the production process;
- the *differences* in times of occurrence of the various other inputs and outputs; and
- the increasing *uncertainty* associated with events the further into the future that their occurrence, magnitude and timing have to be anticipated.

Consequently the economics of forestry is dominated by the cost of time and the uncertainties associated with it. The beauty of the Faustmann solution to the problem of time is that it accommodates all three of these aspects in a single figure and a single operation. Time, as an input, is accounted for by compounding interest on a cost or a revenue item from the date it occurs until the end of the rotation (or series of rotations), or by discounting it to the start of the rotations. Differences in the time distribution of costs and receipts are eliminated by compounding or discounting them to the same point in time; the interest rate at which this is done can be selected to incorporate the uncertainty.

Much of forest economics is therefore concerned with pre-investment assessments of the expected economic performance of options in forest policy and management. In that, the Faustmann approach is not only theoretically correct (Gaffney, 1957), but is indispensable. From that, it is clear that the rate of interest at which the appraisals are made is the most important factor in determining the performance of a given option or the comparative performance of a set of alternative options.

How powerful the interest rate can be is evident from the example whose results are summarized in Tables 1 and 2. Doubling the interest (discount) rate from 4 percent to 8 percent reduces the benefit-cost ratio by as much as it is increased by a fourfold reduction in establishment costs. Or, to put it another way, it is increased by five to 20 times the value which has to be credited to non-revenue services for natural management to break even in an

economic appraisal.

Fourfold increases in productivity or fourfold reductions in costs are not easy to achieve, so it is not hard to see why compound interest has earned the reputation in forestry as a tyrant. It seems, as tyrants do, to dictate and to denounce. It dictates the adoption of plantation systems of high-yielding species on short rotations, and denounces those who persist with natural management systems for an irresponsible disregard of economic reality (Clawson, 1983). But, in reality, it does not necessarily lead to such conclusions. Everything, in fact' depends on the rate of interest. Relatively high rates of interest certainly favour short rotations and plantations, but at low rates the reverse could just as easily apply. Treloar and Morison (1962) showed this switchover effect quite strikingly in their comparison of the financial performance of forestry and agriculture in western Australia. If the same sort of switch applies with natural management as against plantations, then there is less justification for the supine acceptance of compound interest as the Achilles heel of natural management.

To test the possibility, the simplified example used earlier to illustrate the economies of natural management was taken as the basis for a comparison with a representative plantation regime. Benefit-cost ratios for both under a range of discount rates are summarized in Table 3.

Regime	**Discount rate (%)**					
	0	**2**	**4**	**6**	**8**	**10**
Natural management	12.3	4.8	1.8	0.6	0.2	0.1
Plantation	1.3	0.9	0.7	0.5	0.3	0.2
	Natural			*Plantation*		
Mean annual increment (m^3/ha/yr)	1.8			18		
Rotation (yrs)	60			20		
Stumpage price (US$/ha)	15			5		
Establishment costs (US$/ha)	-			-		
Initial	50			1000		
2nd rotation	-			50		
3rd rotation	-			100		
Annual costs (US$/ha/yr)	1			1		

A switch clearly occurs. Up to a discount rate of around 6 percent the natural management regime offers a better financial return than the plantation regime. Above 6 percent the position is reversed. Tests with other combinations of cost and revenue values suggest that the switchover rate is in the 5-6 percent range.

This, it is worth noting, occurs in a purely financial context. If non-revenue considerations - which affect natural management regimes much more than plantations - are included, the switchover rate would move higher. That, however, does not matter. The point is that, up to a certain discount rate, the chances are that natural management is a better option in tropical forestry on financial grounds alone. Up to that point, there is no need to invoke the non-revenue advantages of natural systems or to resort to shadow-pricing to improve the standing of natural management relative to other forms of forest or land use. It all depends on the discount rate.

That raises, of course, the question of what is the correct discount rate to use in the evaluation of options in forestry. So crucial is the question that one would expect it to have been settled long ago, decisively and conclusively. But the fact is that it has not - neither for forestry nor for

any other time-intensive form of economic activity. Actually, there is barely any agreement, let alone unanimity, on what is even an *appropriate* rate. Authoritative support can be found for almost any plausible rate from zero upwards.

Solow (1974), for instance, tends toward the zero-interest implication of Ramsey's argument that it is "ethically indefensible for society to discount future utilities" (Ramsey, 1928). The underlying idea that the interests of future generations are not any less significant than those of the present generation is further developed at some length in Rawls (1971). It is a view of intergenerational relationships, consistent with the attitudes of Melanesian and Polynesian societies, confirming that the conventional Western economic philosophy is by no means of universal validity. With that sort of support, the forest rent doctrine and the conservation view, both of which imply zero interest, are not quite so irrational as many forest economists have assumed.

The zero interest view has not convinced many economists, but there are certainly some who feel that any discounting of the future should be at relatively low rates. Böhm-Bawerk (1929), for instance, argued that we "systematically undervalue our future wants and the means which serve to satisfy them". Much the same point was made by Eckstein, quoted by Peterson (1977): "You cannot really determine your responsibility to unborn generations by using a discount rate which gives priority to current consumption." Such views are quite consistent with the position long held by silviculturists. If compound interest has to be applied in forestry, then the appropriate rate is a relatively low one.

The validity of a special low rate of interest for forestry, together with the extreme of zero interest, is rejected by most economists. That does not prove that the idea is wrong. Indeed it gets some interesting support from Marglin's (1967) investigations of the appropriate discount rate for public investment. His formulation of a synthetic discount rate led, to his evident surprise, to the finding that the appropriate rate decreases with the increasing length of the economic life of the project.

This striking confirmation of the silvicultural case for a special low rate of interest for forestry seems to have gone unnoticed in economic commentary. It is not hard to see why. By far the majority of economists believe that, if there is a social discount rate, then it is very closely related to interest rates applying in the private sector. To admit time-intensive projects as exceptions would weaken that position, so the Marglin paradox is best ignored.

The majority opinion thus favours some form of opportunity cost of capital as the appropriate rate for forestry as a public investment (Walker, 1983). The opportunity cost is then derived from the investment or consumption in the private sector displaced by the diversion of the funds to public investment. The general implication seems to be that the correct rate is thus much higher than what other views would lead to (Baumol, 1983; Fraser, 1985). In effect, this view rejects the Ramsey ethic regarding the rights of one generation relative to succeeding generations.

What is important about these widely differing verdicts on the vital question of the interest rate is that, in the final analysis, they are opinions only. The high interest rates which act against natural management systems in forestry, and against forestry in general, have no more basis than somebody's opinion. Repeated assertion, majority opinion or officially set, they are still no more than opinion.

Another remarkable feature of the discussion over the appropriate rate of interest is that, apart from zero, an actual rate is rarely specified. Occasionally a range is quoted (Fedkiw, 1960; Fraser, 1985), or an absolute lower level is implied (Baumol, 1983), or an arbitrary formula for calculating the rate is offered (Marglin, 1967; Little and Mirlees, 1968). Some treasury departments and institutions such as the World Bank do set quite specific rates to be used for

the appraisal of public investment options, and they seem to range from 7 to 11 percent. But that still reflects only an opinion, and is therefore debatable, as Sugden and Williams (1978) point out.

More often, however, and especially in forestry, the problem is disposed of in phrases such as "at an acceptable rate of interest" (Worrell, 1956), or "the landowner's opportunity cost of capital" (Hyde, 1980), or it is dodged altogether because of the lack of any generally agreed way of choosing the rate (Gregerson and Contreras, 1979). On the face of it, this is a much less satisfactory way than the treasury or bank-set rate. Actually, however, that is not so; it is much more honest and realistic in that it highlights the purely subjective nature of the choice.

All the same, it could be argued that there must be some limits to the range within which the rate must lie. At the lower end there could well be: zero. But that does not resolve the problem at all It leaves the way wide open, as Hiley (1930) noted, for choosing the rate of interest to produce whatever predetermined result is wanted. If there is to be any point in bringing economic considerations into forest policy and management, there has to be a less permissive basis for the interest rate than that.

The problem is what basis to choose. If zero interest is rejected as a general rate for all intergenerational choice, then how far above zero is a generationally neutral or fair rate? The clue may lie in the opportunity cost of capital to the present generation. This is usually - although not altogether justifiably - established from the consumption of investment displaced from the private sector by the social investment. This rate, incidentally, is visualized as a marginal rate, not the average or the highest rates in the private sector. There is, naturally enough, little agreement, except in algebraic terms, on what the rate is or how it might be determined. Algebraic values are, of course, useless for appraisals in practice, so empirical evidence is needed if this approach is to provide the base for the social discount rate.

Some such studies dispel any notion that the opportunity cost of capital, established in this way, would be quite high. Anderson (1983) refers to a study of private sector bond yields in the United States over the period 1960 to 1978, which showed a real rate of return over the long run of around 2.5 percent. Risvand (1984) found that the real rate of interest in Denmark over the 160 years from 1819 to 1979 averaged 2 to 4 percent with no sustained tendency to move up or down over that period. He also found, incidentally, that forestry gave a better long-term real rate of return than the rates earned on bonds or from bank interest. Since these are average rates, the marginal opportunity cost could be expected to be somewhat lower. In the light of such evidence, treasury or bank set rates of 7 to 11 percent must either be unrealistically high, or inclusive of inflation. Adjusting them for inflation puts them in the same 2 to 4 percent category.

One way out of the maze might be to follow what Prest and Turvey (1965) describe as the standard procedure and simply select a rate from those ruling at the time. It is an attractive approach, not least because it seems to dodge the theoretical difficulties. But there are catches in it. For a start, it is still entirely subjective. All that the procedure does is to restrict the range of rates from which the choice can be made. Then the ruling rates still have an inflationary content. The range of real rates, corrected for such distortions, could easily include the switchover rate, leaving the way wide open to choosing a rate on either side of it, which gives whatever result happens to be wanted.

Conclusion

Three points of considerable significance to tropical forest management emerge from this review. They are:

- the economic prospects of natural management are greatly, and perhaps

primarily, governed by the rate of interest projected over time;

- the choice of the rate to use is almost entirely subjective;

- there is little in economic theory or practice to guide or constrain that choice, but the indications are that the appropriate rate is more likely to be at the lower end of any plausible range of real rates than at the upper end.

These findings go a long way toward resolving doubts about the economic feasibility of natural management in the tropical moist forest. It is almost undeniable that natural systems on the whole cannot compete at high rates of interest with alternatives in forestry such as industrial plantations or with alternative forms of land use. The improvements in growth rates and yields, or the increases in average stumpage values needed to overcome the effects of compounding costs or discounting revenues at high rates are unattainable or highly improbable. The extension of the appraisal to a purely economic basis hardly helps either. Even assuming that the net social return from the non-revenue services will be higher under natural management than under alternative forms of forest or land management, the extra value which has to be credited to natural management at high interest rates goes well beyond the credible.

This verdict seems to have been accepted too easily, both by those inclined to natural management and by those who advocate the plantation and agricultural alternatives. The way that acceptance has been won has all the marks of a confidence trick. High rates are needed to demonstrate the uneconomic basis of natural management. At low rates, the reverse could well apply. This important point is rarely referred to in the appraisals which show the economic inefficiency of natural management, while the dubious validity of high rates is never mentioned. Such concealment of vital information is not exactly honest.

It is not, therefore, necessary to defend natural management on the grounds, as I did in 1977, that the economic case against it could be wrong. The case is wrong, and not simply because of its inherent theoretical and practical weaknesses. It is wrong because, at the interest rates which theoretical considerations and empirical studies suggest should be used in forest economics, natural management of the tropical mixed forest is likely to be a better economic and financial proposition than alternative land uses or management systems.

It is actually not quite so straightforward as that, for two reasons. The first is that if long-term, real rates of interest are expected to be several times higher in the future than they have been in the past, and that if they can also be decisively linked to higher social rates, then the economic efficiency of natural management would be greatly reduced. The onus of proof for that lies, however, with those who question natural management on economic grounds. There are few signs as yet to suggest that changes of such a magnitude are coming.

The second is that a demonstration of the efficiency of natural management in capital utilization does not necessarily confirm a similar efficiency in terms of land use. In other words, natural management could still be relatively expensive in its use of land. The point is debatable: the distinction between land and capital virtually disappears when long periods of time are involved. But even if this factor is allowed some validity, any such disparity would tend to be corrected by the longer-term advantages that natural management has over alternative land-use systems. For instance, some timbers and some non-revenue services are unique to the natural tropical mixed forests. They cannot be produced elsewhere or other than by natural management and they cannot be adequately replaced by substitutes.

The market outlook for them is, therefore, the direct opposite of the weak prospects for most of the products of the agricultural and plantation alternatives (Malaysia, 1986). In such circumstances, the relative economic prospects for natural management, no matter how they are measured, can only improve.

In effect, these reservations act to strengthen the conclusion that natural management of the tropical mixed forest, wherever it is ecologically feasible, is also, on its own merits, economically preferable.

References

ANDERSON, D.A. 1983, Comments on J.L. Walker. National forest planning: an economic critique. *In* R.A. Sedjo, ed. *Governmental intervention social needs and the management of US forests*, p. 247-300. Baltimore. Resources for the Future, Johns Hopkins Univ. Press.

BAUMOL, W.J. As quoted by J.L. Walker. 1983, *In* R.A. Sedjo, ed. *Governmental intervention, social needs and the management of US forests*. (Chapter 7). Baltimore, Resources for the Future, Johns Hopkins Univ. Press.

BLAUG, M. 1978, *Economic theory in retrospect.* Cambridge, UK, Cambridge Univ. Press.

BÖHM-BAWERK, E. VON. 1959, *Capital and interest. Vol. 2*. (Translation of 1929 ed.) Illinois, USA, South Holland Publ.

CATINOT, R. 1974, Le présent et l'avenir des forêts tropicales humides. *Bois et forêts des tropiques,* (154): 3-16.

CLAWSON. M. 1983, Problems of public investment in forestry. *In* R.A. Sedjo, ed. *Governmental intervention, social needs and the management of US forests.* (Chapter 7). Baltimore, Resources for the Future, Johns Hopkins Univ. Press.

FAO. 1985a, *Forest product prices. 1965-1984.* FAO Forestry Paper No. 61, Rome, FAO.

FAO. 1985b, *Tropical Forestry Action Plan.* Rome, FAO.

FEDKIW, J. 1960, Financial management of large forest ownerships. *Yale Univ. School of Forestry Bull.,* 66: 1-45.

FRASER, G.A. 1985, *Benefit-cost analysis of forestry investments.* Victoria. BC, Canadian For. Serv., Pacific For. Centre.

GAFFNEY, M.M. 1957, *Concepts of financial maturity of timber and other assets.* Raleigh, N.C., A.F. Info. Series No. 62. Dept Agric. Economics, North Carolina State Coll.

GREGERSON, H.M. & CONTRERAS, A.H. 1979, *Economic analysis of forestry products.* FAO Forestry Paper No. 17, Rome, FAO.

HILEY, W.F. 1930, *The economics of forestry.* Oxford, Oxford Univ. Press.

HYDE, W.F. 1980, *Timber supply, land allocation and economic efficiency.* Baltimore, Johns Hopkins Univ. Press.

JABIL, M. 1983, Problems and prospects in tropical rain forest management for sustained yield. *Mal. For*., 46 (4): 398-408.

KARMACK, A.M. 1983, *Economics and the real world.* Oxford, Blackwell.

LESLIE, A.J. 1977, Where contradictory theory and practice co-exist. *Unasylva,* 29 (115): 2-17.

LESLIE. A.J. 1983, *The economic evaluation of tropical forestry.* Gympie, Queensland, Australia, Workshop on Tropical Forest Management, ADAB/Dev. Studies Centre, A.N.U.

LITTLE, I.M.D. & MIRLEES, J.A. 1968, *Manual of industrial project analysis in developing countries. Vol. II. Social cost-benefit analysis*. Paris, Development Centre, OECD.

MALAYSIA. 1986, Ministry of Primary Industries. International Seminar on Commodities. Kuala Lumpur.

MARGLIN. S.A. 1967, *Public investment criteria.* London. George Allen & Unwin.

MASSON, J.A. 1983, *Management of tropical mixed forests: preliminary assessment of present status.* FO: Misc./83/17. Rome, FAO.

MYERS. N. 1980, The present status and future prospects of tropical moist forests. *Env. Cons.,* 7 (2): 101-114.

MYRDAL, G.K. 1972, *Against the stream.* London, Macmillan.

PETERSON, R.M. 1977, The role of interest groups in policy formulation. *In* F.J. Convery & J.E. Davis, eds. *Centres of influence and US forest policy.* Durham, North Carolina, Duke Univ. School For. and Env. Studies.

PREST, A.R. & TURVEY, R. 1965, Cost-benefit analysis: a survey. *Econ. J.:* reprinted in *Surveys of economic theory, Vol. III* as Chapter XIII. London, American Economic Association & Royal Econ. Soc., Macmillan.

RAMSEY, F.P. 1928, A mathematical theory of saving. *Econ. J.,* 38.

RAWLS, J. 1971, *A theory of justice.* Boston, Harvard Univ. Press.

RISVAND, J. 1984, Rente Inflation og Skat I Skovbrugrt. *Skoven,* 8: 215-7.

SELIGMAN, B.B. 1962, 1971, *Main currents*, *in modern economics.* Chicago, Free Press of Glencoe, Quadrangle Books Edition.

SINDEN, J.A. & WORRELL, A.C. 1979, *Unpriced values*. New York, Wiley.

SOLOW, R.M. 1974, The economics of resources or the resources of economics. *Am. Econ. Rev.,* 64 (2): 1-14.

SUGDEN, R. & WILLIAMS, A. 1978, *The principles* of *practical cost-benefit analysis.* Oxford. Oxford Univ. Press.

TRELOAR, D.W.G. & MORISON. I.C. 1962, *Economic comparisons of forestry and agriculture.* Perth; Ag. Econ. Res. Report No. 3, Inst. Agric., Univ. of Western Australia.

WALKER, J.L. 1983, National forest planning: an economic critique. *In* R.A. Sedjo, ed. *Governmental interventions, social needs and the management of US forests.* (Chapter 8). Baltimore. Resources for the Future. Johns Hopkins Univ. Press.

WESTOBY, J.C. 1982, *Halting tropical deforestation: the role of technology.* Draft for Office Tech. Assessment, Congress of the United States, Washington. D.C.

WORRELL, A.C. 1956, Optimum intensity of forest land use on a regional basis. *For. Sci.,* 2 (3): 199-240.