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# 17. Is sustainable forestry economically possible?

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## 1. The Issue

Concern about the rate at which the world's forests are being depleted is widespread. Recent international calls for radical efforts to reduce deforestation include the United Nations Inter-governmental Forum on Forests of the UN Commission on Sustainable Development (1999), and the World Commission on Forests and Sustainable Development (1999). This concern reflects an appreciation of the ecological and economic functions of forests: as providers of timber and many non-timber predicts, as the habitat for much of the world's biological diversity, and as regulators of local, regional and global environments. These functions are at risk. Most of the forest clearance is in areas of high forest cover and high human population pressure in tropical areas for agriculture. In temperate and boreal areas the pressures from logging are more important. But in all areas, forestry itself has an important role to play both as a partial cause of deforestation, and, if practiced wisely, as a potential source of salvation for at least some of the world's forests. In terms of its causal role, forestry tends to open up primary forest areas, enabling colonists to move in, using roads forged by the timber companies. In some parts of the world, forests are converted not to agriculture but to biomass plantations of fast growing trees or to other agro-industries based on tree-crop plantations such as palm oil and rubber. Here the primary agent is not the peasant, but the richer elements of local and international society.

How, then, can the world's forests be used more wisely? It is this admittedly grand and complex question that we seek to answer in this chapter. Some argue for outright protection, caricatured perhaps in the phrase 'fence and forget'. Others argue for 'sustainable forest management', and still others for systems of forest management that rely on acceptance of an initial period of exploitation of valuable species followed by outright protection. The issue, then, is the *optimal use of forested land*[1], which begs the question of what is meant by 'optimal'. This is addressed shortly.

[1] We use the term forested land rather than forest land to make it clear that we are dealing with land that still has forest on it, rather than land which has a potential to be used for forest in one form or another.

Forested land may be retained as forest or it may be converted to non-forest uses such as crop agriculture, livestock, and urban expansion, or to industrial tree crops. The first question, then, is under what circumstances it is better to convert forest land to non-forest uses, and when not. If it can be shown that forest land is best retained as forest - where 'best' needs to defined (see below) - the further issue arises of *what kind of forestry* is to be preferred.. Here the issue is clouded in terminological confusion because the words used in reference to forestry have come to mean different things to different people. But, in order to focus the debate we choose three archetypes familiar in the literature: *conventional logging* (CL), *sustainable timber management* (STM) and *sustainable forest management* (SFM). We adopt this terminology not because we think it is free from misinterpretation, but because the literature on the role of forestry in deforestation has adopted it, making it extremely difficult to elicit the lessons from that literature without using that language. We devote some time to explaining what we mean by the terms below and why, in an ideal world, we would prefer a different terminology. For the moment, we take CL to be more short-term in focus, less concerned with forest regeneration through management, and often lacking in government control. We take STM to be a forest management system that aims for sustained timber yields. We take SFM to be a system of forest management that aims for sustained yields of multi-products from the forest.

There have been recent challenges to the idea that conservation is best served through sustainable timber or forest management (Bowles *et al.,* 1998; Vincent, 1992; Kishor and Constantino, 1993; Howard et al, 1996; Rice et al, 1997). One argument is that conservation can only be served by outright protection (Bowles *et al.,* 1998), i.e. while SFM has the potential for protection, it is inferior to outright protection. Another view is that conservation might be better served by an initial period of well managed logging followed by protection (Rice *et al.,* 1998a; Rice *et al.,* 1998b; Cannon *et al.,* 1998). Against this, it is argued that outright protection has an extremely limited chance of being successful in face of the high costs of protection, the need to use forests for profit, and human population growth: in many places sustainable forestry management offers the only chance of maintaining forests and biodiversity (Whitmore, 1999).

## 2. The Theme

In terms of the debate about the optimal use of forested lands, the existing literature tends to focus on the *financial* returns from STM, SFM and CL and on physical descriptions of the comparative *ecological impact profiles* of these forms of forest use management. The focus on financial returns is justified in so far as actual forest use is determined by relative profits. The focus on ecological impact profiles is relevant for a full *economic* assessment. An economic assessment makes three potentially major adjustments to a financial analysis: the existing financial costs and benefits are adjusted to 'shadow values' to reflect the true opportunity cost of the resources involved; and environmental and social costs and benefits ('externalities') are included both at the national level, and at the global level.

(1) The first modification adjusts *financial* costs and benefits to reflect *shadow prices*. A shadow price, say the price of labour or the exchange rate, differs from a financial price in that it reflects the true *opportunity cost* of the resources in question. As an instance, the ruling wage rate would be used in a financial analysis, but if the labour employed would otherwise be unemployed, the shadow wage rate will tend to be closer to zero (since the wage in alternative employment is, effectively, zero). A shadow exchange rate is the rate that would prevail if trade was free and open, rather than, as is often the case, managed through trade quotas and tariffs. It is important to understand that this shift to shadow pricing alters the stakeholder perspective. Whereas financial costs and benefits are relevant to the logger or concessionaire, shadow priced costs and benefits are relevant from the standpoint of the forest owning nation.

(2) The second modification adds in all environmental and social consequences which affect the wellbeing of anyone within the *nation*. Thus, if indigenous peoples are adversely affected by the forest development, their wellbeing must be counted in any economic study. Similarly, if logging gives rise to soil erosion, loss of flood control, loss of biodiversity, etc., an economic analysis would attempt to take these into account. It is important to understand that ecological functions of forests have a parallel in economic magnitudes – all ecological functions are economic functions.

(3) The third modification constitutes a *global* analysis and would additionally include the gains and losses of people outside the country in which the forest is located. Thus, if individuals in another country experience a loss of wellbeing from knowing that deforestation, perhaps indirectly caused through logging, is taking place, that loss of wellbeing has also to be accounted for. This loss of wellbeing is relevant regardless of whether it emanates from a loss of any *use value* (e.g. ecotourism, or carbon storage ) or any loss of *non-use value*, i.e. wellbeing unassociated with any direct use of the forest.

It is not always appreciated that economic analysis is potentially quite different to financial analysis. An economic analysis might, for example, sanction an activity that is wholly unprofitable from a financial standpoint.

In this chapter we try to build up the overall picture, as best we can, by beginning with financial analysis and extending it to full global economic assessment. It is important to understand that a global economic assessment is useful only in so far as it *demonstrates* the superiority of one form of forest land use over another, i.e. it shows, in an accounting sense, which land use is 'best'. Unless there are corresponding cash flows which *capture* those values, the exercise remains interesting but unlikely to cause changes in the way forests are treated. For example, SFM may turn out to be financially inferior to CL, but this does not mean that SFM is to be dismissed. An economic analysis that includes all social and environmental externalities can guide us to the relevant conclusion. Now suppose the economic analysis demonstrates that SFM is superior to CL, regardless of the contrary finding for the financial analysis. Since the financial costs and benefits 'drive' the land use decision, SFM can only be introduced if forest land use is regulated in some way, or if forest land users are compensated for the difference between the profits under CL and the profits under SFM. In this chapter we are concerned mainly with the demonstration phase. The broad issue of designing compensatory and 'capture' incentives is not addressed in detail here except indirectly by reference to the literature, e.g. Pearce (1996), Panayotou and Ashton (1992). Capture mechanisms include debt-for-nature swaps, carbon trading, forest certification and so on.

## 3. The Terminology of Forest Management

As noted above, the terminology used in the debate over the appropriate use of forested land has become confusing.

'Logging' rightly refers to the process of harvesting timber from a forest, but whereas timber harvesting appears 'value-neutral', logging has come to be regarded as necessarily destructive and evoking the picture of huge clear-cuts on steep slopes. Logging, however, can be a legitimate part of good or 'wise' forest management. In the same way, the literature now refers to 'conventional logging' as if it too characterises undesirable treatment of forest. To a forester, however, conventional logging might characterise standard forest management practice as opposed to unconventional means of timber extraction, e.g. with the use of helicopters. But some conventional logging is not practiced wisely, so that it becomes possible to contrast poor management practice with, say, reduced impact logging (RIL). To a forester, RIL would simply be a feature of any good management system. In what follows we maintain the more popular image of conventional logging as meaning use of the forest for short-term timber supplies, aimed solely at short-term profits and without significant government control. Management plans may or may not exist for this type of timber harvesting, and, while the potential is there for switching to a more long-term sustained timber yield, it is more likely that forest degradation, forest loss and conversion to non-forest use will follow.

In terms of timber volumes, conventional timber harvesting may be sustainable or unsustainable. But the connotation of conventional logging is that it is often unsustainable, i.e. not focused on long term timber supplies. Sustainable timber management (STM) therefore arises when a forest management plan is fully implemented for timber is fully implemented and focuses on the long term. Note that the sustained yield does not necessarily mean that one species is sustained over time. As the forest structure and composition change over time because of harvesting or natural succession, harvested species may change.

Sustainable forest management embraces the view of the forest as yielding many different products and providing many different ecological services. Sustainable forest management will therefore produce an array of products and services which may or may not include timber. SFM therefore relates to the *multiple use* of the forest. To a forester, the term 'management' could relate to the management of resources, inventorying and yield calculation, and to silvicultural practice (e.g. climber cutting), so that, on some definitions, SFM is already embodied in good practice timber harvesting. Again, then, the terminology of SFM is not ideal but is retained here to convey the idea of multi-product uses and with a focus on the longer term.

'Protection' is also ambiguous. For ardent environmentalists it almost certainly means the maintenance of the structure and composition of the forest without change caused by human intervention. For others it risks being confused with 'conservation' which is the proper management of the forest for the sustained yield of some product(s), service(s), or some combination of products and services. Again, a forester would argue that he or she has always been in the business of conservation in this sense (as indicated by the more traditional term of 'conservator'). 'Protection' also conjures up the image of leaving a forest totally alone when, in practice, some management of invasive exotic species, fire etc. is still likely to be required to conserve structure and composition. If so, it would appear that private interests will not result in protection because it yields no return but does involve costs such as monitoring, fencing etc. In practice, private interests may well engage in protection since private benefits can accrue from conservation of the carbon content of the forest – see Section 8.5 - and protection may be consistent with some uses of the protected forest, e.g. ecotourism.

Clearly, the language in the forest debate has varying interpretations. We attempt a typology in Figure 1.

**Figure 1: Typology of Forest Uses**

| | Short-term | Long-term | | |
|---|---|---|---|---|
| | Timber | Timber | Multiple purpose | Composition and structure |
| *Poorly managed* | Conventional logging: short-term timber supplies, generally unsupervised | | | |
| *Well Managed* | Reduced impact logging, probably supervised | Sustainable timber management: long term sustained multiple benefits | Sustainable forest management: long term sustained multiple benefits | 'Protection': probably involving some management |

## 4. The Meaning of 'Optimal' Forest Land Use

What is 'optimal' depends on the viewpoint of the economic agent making the decision to convert forest land or to adopt a particular forestry regime. Hence we need to identify the *stakeholders*.

From the standpoint of most *logging companies* a forest exists to be logged. In principle, a forest will not be logged if it is unprofitable to do so, although it is perfectly feasible that loggers may log land at a loss if subsidies prevail. If the forest is profitable, the management regime used will generally be that which maximises profits, subject to any regulations on harvesting that may be in place. In addition to obligations under relevant legislation, logging companies may voluntarily attenuate maximum profits if they feel some obligation towards the environment. In some cases it would appear that the most profitable regime is not employed. RIL might, for example, lower costs but not be used, perhaps because of ignorance or for reasons that remain unclear.

Forest owners include local communities, indigenous groups, non-logging companies and individuals. In these cases there may be a mix of motives with regard to the forest: as a supplier of products, including timber; as an environmental resource; as a stewardship objective, and so on.

From the standpoint of *forest dwellers* a forest exists to provide an array of ecological and economic functions ranging from timber, fuelwood, and wildmeat to protection against floods.

From the standpoint of *poor agricultural colonists* forests exist for the land they provide for timber, crops and livestock, mainly the latter two. The productivity of this land is temporarily advanced through burning and clearance, and may be more permanently advanced by the use of inputs such as fertiliser. Such colonists may nonetheless have complex mixes of motives. Thus, Mourato and Parikh (1999) show that slash and burn cultivators in Peru exhibit a strong concern for the conservation values of their forests. The image of colonists as being poor is not always correct: they may also be wealthy individuals or companies looking to exploit subsidies, to speculate on land values, or to anticipate conversion to lucrative plantations and agro-industries.

From the standpoint of the *conservationist* the forest exists to provide ecological functions, amenity and the provision of wellbeing to forest peoples. Motivations vary and may range from a desire to make direct use of the forest (e.g. ecotourism) to a concern for the intrinsic rights of biodiversity to exist.

From the standpoint of *national governments*, forests may serve any of the above functions depending on the extent to which governments have the wellbeing of particular stakeholders at heart. They may prefer :

- logging to preservation because it provides employment and tax income;
- conversion because it may yield higher returns than timber production;
- conversion and colonisation because of the need to 'establish' political frontiers and accommodate migrants;
- conservation because of a concern for vulnerable indigenous groups, because of the potential income from sustainable uses of the forest, because there are financial inducements to conserve, or because they have forest protection as a general social objective.

From the standpoint of the *world as a whole* there may be a preference to log forests for the valuable timber they contain, or to conserve forests for their local and global ecological functions. In the latter case, there may be a preference to conserve forests because of their role in providing biodiversity and in storing carbon which would otherwise be released to the atmosphere, contributing to global warming. The relevant agents reflecting 'world' interests include some activities by bilateral and multinational aid agencies, various UN organizations not directly involved with aid, the Global Environment Facility, and international NGOs.

The viewpoints of the stakeholders necessarily conflict, otherwise there would be no 'forest problem'. Different uses of forested land are often incompatible. There are only two options for 'resolving' these conflicts of values. The first is to impose a given use on all stakeholders, regardless of the differences of viewpoint. This 'solution' is potentially unstable because one or more stakeholders will lose from the imposed land use. Hence they have a continuing incentive to break the agreement by securing its subsequent rejection, or by 'illegally' using the forest for their own purposes. The second is to find an agreement which adopts a given use of the forest land and in which those who lose are compensated in some way for forgoing their use of the land. On this solution, all stakeholders are (ideally) better off with the agreed land use than they were without it.

The second solution suggests the meaning of 'optimal': it is a land use which is judged socially the most beneficial overall, but in which those who lose from the land use are compensated for their losses. This definition accords with elementary game theory (for a brief introduction see Perman *et al*., 1999).

In practice, actual compensation for losses is often not feasible. At the very least then, forest land should be allocated to those uses which maximise, as far as possible, the aggregate *social value of the forest land.* If gains and losses are measured in monetary terms, then this requirement is equivalent to a standard cost-benefit analysis approach and the compensation is potential rather than actual. Put another way, gainers have to be able to compensate losers and still have net gains to show (Pearce, 1986). In practice, while we may not be able to assign economic values to all functions, the cost-benefit approach is a reasonable way of organising the framework for analysis.

A convenient language to describe stakeholders' interests is that of 'private' and 'social' gains and losses. 'Private' refers to the private interests of the stakeholder, i.e. what benefits him or her. 'Social' takes the wider, social perspective and the jurisdiction may be local, national, regional or global. In theory, governments or global agencies should take the social standpoint, but it is well known that this is not always the case. Both perspectives are relevant to determining 'optimal' forest land use because adopting a social perspective without acknowledging that some stakeholders' private interests may be compromised will, as noted above, be potentially unstable. For an overview of conflicts in forest land use see Chapter 7 of Panayotou and Ashton (1992).

## Table 1: Motivations for stakeholder preferences for forest land use

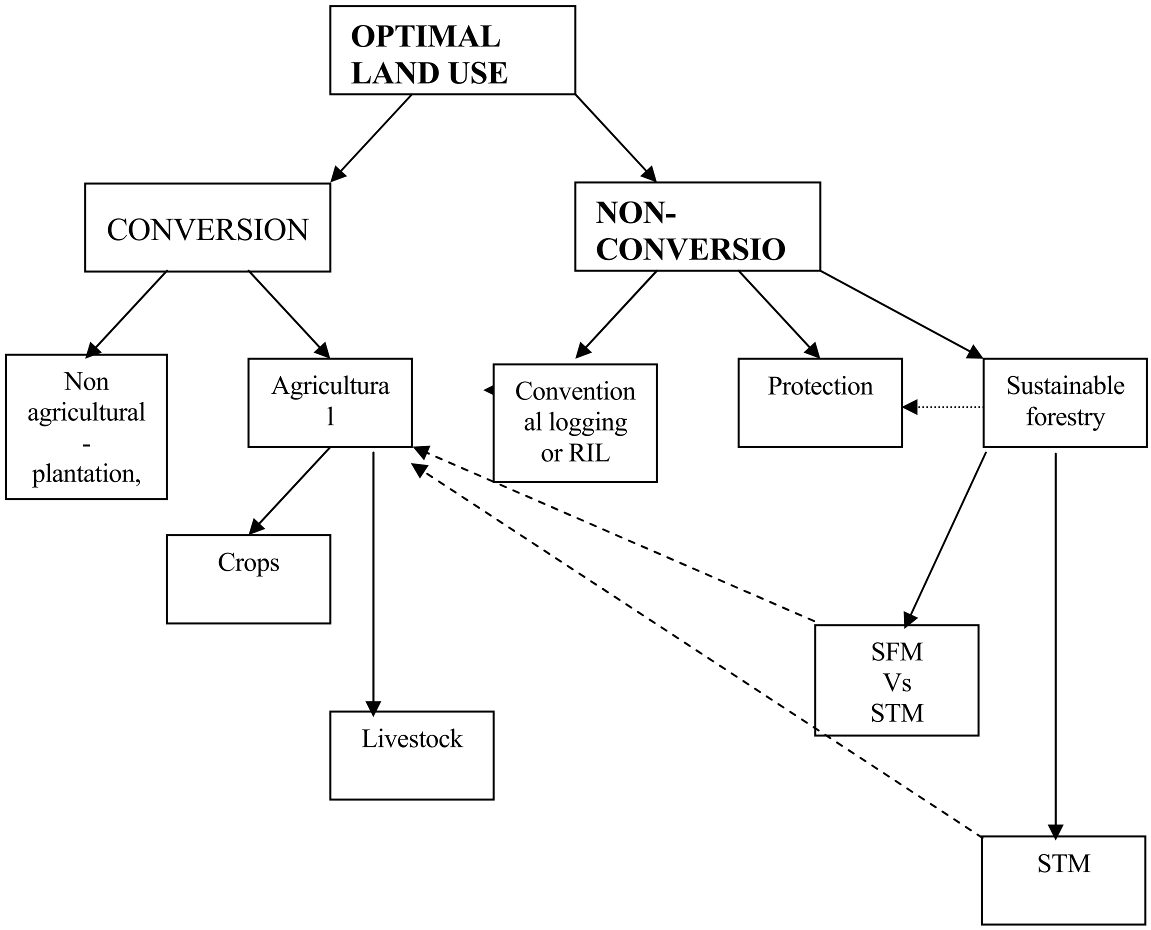
| | Motivations for land use preference by stakeholder | | | | |
|---|---|---|---|---|---|
| | Conversion - agriculture | Conversion - other | CL | SFM | Protection |
| Logger | | | Profit if CL>SFM | Profit if SFM>CL | |
| Forest dweller | | | | Timber and NTFPs | |
| Owner (other than government) | Profit | Profit | Profit if CL>SFM | Profit if SFM>CL, or non-market benefits of SFM | Stewardship motives |
| Colonist (poor and rich) | Profit | Profit | Profit | May log more sustainably | Possible? |
| Conservationis t | | | Timber and NTFPs if RIL | Timber and NTFPs if SFM ⇒ Protection | Ecological benefits |
| Government | Employment Migration Border security | Employment Border security Roads | Tax revenues Timber and NTFPs if CL ⇒ Protection | Tax revenues Timber and NTFPs if SFM ⇒ Protection | Ecological benefits |
| World | | | Timber and NTFPs if CL ⇒ Protection | Timber and NTFPs especially carbon benefits. | Ecological benefits, especially carbon and biodiversity |

Note: NTFP = non timber forest products

Table 1 encapsulates the different interests of the forest stakeholders, albeit in simplistic terms. The reality is that motivations will often be complex mixes of those shown.

Figure 2 shows competing and complementary forest land uses in diagrammatic form. Note that conventional logging (CL) is *potentially* capable of leading to protection if well managed logging occurs in an initial period after which loggers leave the area and protective policies are introduced. CL is also, however, linked to conversion since the initial period of logging opens up the forest area to colonists and industrial uses through the construction of roads. Which of these views is correct is an empirical matter. CL could, in principle, also lead to STM if initial-phase loggers focus on only large specimens, collateral damage is minimised and regeneration is fast. STM, of course, also opens up the forest and relies for its avoidance of colonisation and conversion on the management of the forest for longer-term purposes. In practice, CL followed by STM/SFM seems unlikely due to soil and biomass damage in the CL phase. Nonetheless, we retain the possibility of the sequence from CL to STM/SFM.

**Figure 2: Forest land use**




## 5. The Meaning of Sustainable Forest Management

Optimal land use is not necessarily the same thing as sustainable land use (Toman and Ashton, 1994)[2]. The current debate about forestry is partly about sustainability, i.e. about making use of forested land in a sustainable fashion. In large part, converting forest land to agriculture – in tropical regions – is not sustainable because soils often do not have the capacity to sustain agricultural activity indefinitely, although the case for perennials is far stronger in this respect. There are, however, many cases in which tropical forests have been converted and successful agriculture follows (see e.g. Schneider, 1995). In other cases, provided suitable fallow periods prevail, forested land can be converted for short term

[2] Optimality tends to be defined in terms of maximising the net present value (NPV) of the flow of services from the forest resource. Because of discounting, it may be possible to maximise NPV from very short term exploitation of the forest even if high economic values are attached to long term benefits. Sustainable uses, on the other hand, may yield short term gains below those of exploitative uses, but which extend into the indefinite future. Discounting the yields over an infinite time horizon may nonetheless result in the short term use being favoured. On the contrast between optimality and sustainability see Pearce (1999).

agricultural use and then be cleared again and reused after the fallow period. This 'cycle' of agriculture and forest regeneration is also potentially sustainable.

As noted above, the debate about appropriate forestry mixes two different aspects of sustainability: sustainable *timber* management (STM) in which the focus is on a sustained yield of timber over long time periods; and sustainable *forest* management (SFM) in which the focus is on the many products and services of the forest sustained over long periods of time. While it is generally thought that STM is consistent with SFM, it is at least open to argument that STM will give a less sustainable flow of non-timber products *relative to* SFM. Thus, it is important to distinguish STM from SFM.

In sustainable timber management, timber is extracted with regard to a continuous future supply of wood through investment in regeneration. STM also tends to be associated with minimisation of damage to residual stands, a point emphasised by Vanclay (1996), possible investment in finding uses for currently non-merchantable species, and accelerated growth of merchantable species in managed stands.

With SFM, non-timber products and ecological services may also be exploited, e.g. through carbon trades, bio-prospecting, debt-for-nature swaps etc. Social uses of forest may also be taken into account (indigenous peoples). Thus SFM is: 'management of primary or secondary forests for the sustained production of timber or other products or both in which forest cover is maintained indefinitely' (Dickinson *et al.,* 1996). Reid and Rice (1997) suggest that the primary management objective of SFM is 'obtaining a constant or increased flow of wood from a forest whose natural structure and species composition are maintained to some degree, though not entirely', a definition that, nonetheless, interestingly makes no reference to ecosystem function or ecological processes. IFF (1999) state: 'Non market forest goods and services and, moreover, cultural, spiritual and ethical values of forests are fundamental considerations of sustainable forest management. The importance of these contributions of forests should not be contested in principle, even if they cannot be denominated in monetary terms'.

This quotation emphasises the view that SFM extends way beyond products and ecological services. Perhaps the most complete definition comes from Bruenig (1996):

'….management should aim at forest structures which keep the rainforest ecosystems as robust, elastic, versatile, adaptable, resistant, resilient and tolerant as possible; canopy openings should be kept within the limits of natural gap formation; stand and soil damage must be minimised; felling cycles must be sufficiently long and tree marking so designed that a selection forestry canopy structure and a self regulating stand table are maintained without, or with very little, silvicultural manipulation; production of timber should aim for high quality and versatility…..The basic principle is to mimic nature as closely as possible to make profitable use of the natural ecosystem dynamics and adaptability, and reduce costs and risks…'.

## 6. The Context for the Analysis

The context for the remainder of the chapter is one where the starting point is an existing forest. Thus, we do not discuss the optimal use of bare or degraded land. Additionally, although land uses that involve conversion of the forest are relevant to the analysis, they are incidental to the main focus which is on the appropriate form of forestry. It may or may not be the case that land conversion is socially or privately 'better' than a given forestry use.

Finally, outright protection is also relevant to the analysis but is not the main focus. Like conversion, protection has to be part of the analysis because forest practices are capable of being a precursor to a protected area classification. Conventional logging, for example, is frequently a precursor to agricultural colonization, and hence land conversion. One current argument is that protection might follow on from an initial period of logging. The economics of this option depend in part on the economics of protection. It is widely thought that outright protection is expensive and ineffective. Hence 'log and protect' is not viable, whereas SFM might be. Bruner *et al*. (2001).suggest, however, that protection policies have been generally effective in preventing further land use change. Moreover, protection has not been expensive. There is also some evidence that conventional logging has not been as intensive as sustainable logging. Logging also reduces the financial value of subsequent logging, so that the opportunity cost of committing to conservation after a round of logging is correspondingly low. Clearly, there is room for considerable debate over the relative merits of SFM and the log-and-protect options.

## 7. The Private Interests of the Logging Companies

### 7.1 The empirical evidence

From the logging firm's point of view, the use of the forest will be dictated by the option providing the largest private financial rate of return. Empirical evidence relating to these rates of return is limited. The results of a literature search are given in Table 2. A particular problem concerns the fact that STM and SFM systems have rarely been in place long enough for an accurate picture on financial returns to be obtained (Dickinson *et al.,* 1996). Furthermore, it is seldom to the logging firm's advantage to reveal the actual costs of logging operations. Double accounting is therefore commonplace when record books are accessible at all.

## Table 2: The financial profitability of STM/SFM and CL

| Study | Country | Type of forestry | IRR, NPV (DR) | Ratio profits CL to SFM | Comment |
|---|---|---|---|---|---|
| Bann, 1997 | Cambodia | STM, CL | CL = $1,697 ha STM = $408 ha (6%) | 4.1 | 90 yr x 3 cutting cycle for STM; 30 yr liquidation for CL |
| Barreto *et al*, 1998 | Brazil | STM, CL | $430 ha (20%) | n.a | STM profitable |
| Barros and Uhl, 1995 | Brazil | CL | 14-26% | n.a | Authors argue STM is possible |
| Boscolo & Mendelsohn 1998 | Malaysia | RIL vs CL | $4400 ha CL $2660 ha STM | 1.66 | STM Assumes RIL and >60 cm dbh |
| Browder *et al.,* 1996 | Brazil | New planting on degraded fallow; agro-forestry; mahogany | NPV = $226 ha degraded fallow; $-50 ha; agro-forestry; $721 ha pure stand plantation | | Not strictly comparable to other studies as new planting |
| Bruenig (n.d) | Malaysia | CL vs STM | | CL>STM | Quoted in FAO, 1999 |
| Dixon *et al*., 1994 | Chile | CL vs SFM | $500-3000 per ha more than SFM | | |
| FAO, 1997 | Brazil | RIL vs CL | | CL>STM? | Not quantified |
| Hardner and Rice, 1994 | Brazil | STM vs CL | | CL > STM | |
| Howard and Valerio, 1996 | Costa Rica | STM vs conversion | STM in South $1340-1612 per ha; in North $671-1142 per ha (10%) | STM > ranching but possibly not with crops | Strong sensitivity to parameters for crops |
| Howard *et al.,* 1996 | Bolivia | STM vs CL | CL $334-449 ha STM $204-263 ha (10%) | 1.3 – 1.7 | |
| Johns *et al.*, 1996 | Brazil | RIL vs CL | | 0.75 | needs to be checked |
| Kishor and Constantino, 1993 | Costa Rica | STM vs CL vs ranching | Liquidation=$1292 ha Ranching= $1319 ha STM = $854 ha. (8%) | 1.50 | Liquidation involves 60% cover removal |
| Haltia and Keipi, 1997 | Costa Rica | STM vs ranching | Managed nat. forest $294 ha better than ranching | | Reworks Kishor and Constantino |

**Table 2: continued**

| | | | | | |
|---|---|---|---|---|---|
| Kollert *et al.,* 1995 | Malaysia | STM | CL > STM | | STM profitable |
| Kumari, 1996 | Malaysia | STM vs CL | CL = $860-1380 ha STM = $322-$944 ha | 1.5 – 1.7 (taking 'best' STM and same damage levels) | |
| Laarman *et al.,* 1995 | Philip-pines | Community forest, STM | STM = $638 ha (12%) | | STM profitable |
| Mendoza and Ayemou, 1992 | Ivory Coast | STM vs CL | STM + processing = $160 ha (10%), but CL >STM | | Check |
| Peters *et al.,* 1989 | Peru | SFM | $933 ha (5%) | 3.0 | Disputed study |
| Pinedo-Vasquez, *et al.,* 1992 | Peru | Community forest, CL | 254% return on annual investment | | Check |
| Richards *et al.,* 1991 | Mexico | Community forest, STM | 14-15% annual return on capital, including processing | | |
| Shawahid *et al.,* 1997 | Malaysia | Protection vs RIL | Protection = 10.4 mR, RIL = 26.6 mR (DR=?) | n.a | Protection less desirable than RIL |
| Southgate and Elgegren, 1995 | Peru | STM | Negative NPV | | Adverse public policy and guerrila warfare. NPV could have exceeded opp.cost of STM |
| Stone, 1996 | Brazil | Unregulated CL | 8% profit margin for small mills, 18% for large mills | | Revisits Verissimo *et al.,* 1992 |
| Uhl *et al.*, 1991 | Brazil | Selective cut followed by conversion | | C100% annual return | |
| *Verissimo et al.,* 1995 | Brazil | Unregulated single selective cut, but with regeneration | 28% annual profit including processing | | Mahogany 'mining': few trees left |

**Table 2: continued**

| | | | | | |
|---|---|---|---|---|---|
| Verissimo *et al.,* 1992 | Brazil | STM vs CL | STM has 25% annual return on investment including processing | 26 (10%)<br>19 (5%) | |
| World Bank (summarised in Grut, 1990) | Ghana<br><br>Guinea | RIL<br><br>SFM | 25% IRR at border prices<br><br>34% IRR at border prices | | Use of border prices indicates an economic analysis rather than a financial analysis |

Sources and notes:
Two literature overviews form the core of the table (Gullison *et al.,* 1998, and FAO, 1999), but some entries have been modified and a number of additional studies have been added. IRR = internal rate of return. NPV = net present value. Where available, discount rates used in the studies are shown in brackets. '>' means 'more profitable than'.

Those few studies that compare STM/SFM and CL therefore tend to be based on financial model simulations. Additionally, where there is additional evidence on the rate of return to STM/SFM, the relevant studies often do not attempt a comparison with CL, contenting themselves with a demonstration that STM/SFM is profitable *per se*. Some of the analyses are also not very clear on precisely what the forest 'management' regime is.

While the quality of the analysis in some of the studies leaves something to be desired, the general conclusions emerging from Table 2 are the following: (a) that STM is potentially profitable at 'reasonable' discount rates of, say 5-10% (in real terms) - it is possible that financial viability would be doubtful at higher rates; and (b) that STM is almost systematically less profitable than 'liquidation' forestry and other forms of conventional logging. These conclusions echo those already reached by other commentators, e.g. Bach and Gram (1996).

Nonetheless, while this inequality of profitability explains the widespread preference of loggers for CL, it does not justify it. The reason for this, as indicated previously, is that the financial cost benefit calculation of the logger is not the same as that for society generally and certainly not for the world as a whole.

## 7.2 Factors that could favour the financial profitability of STM

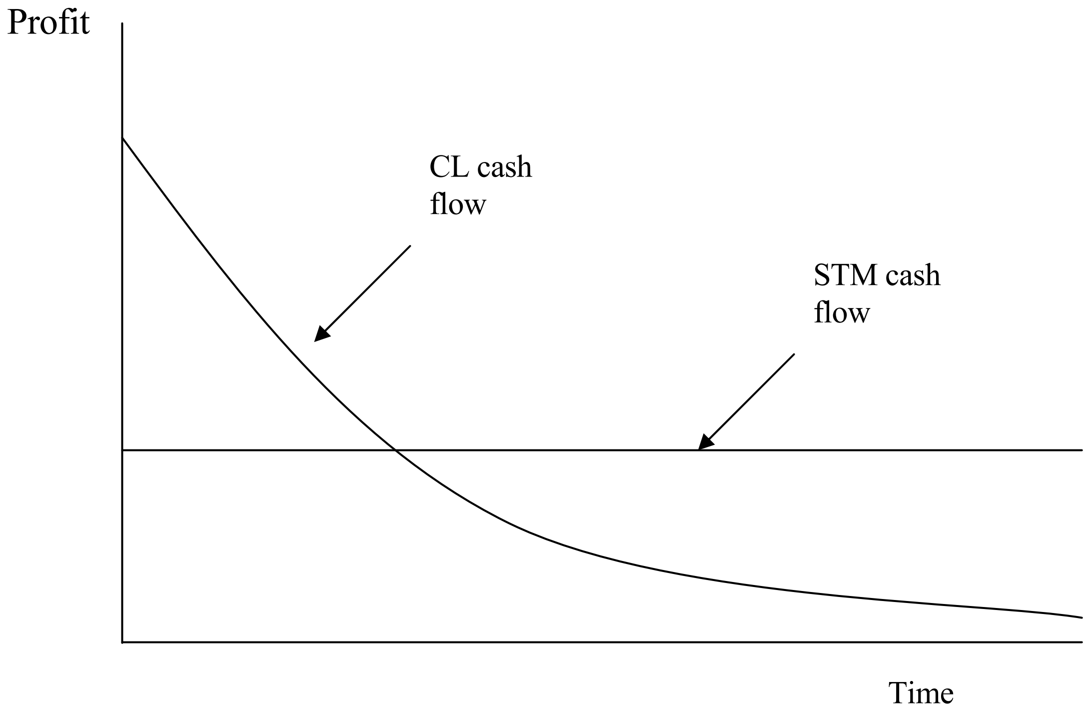
Advocates of STM have drawn attention to four main factors that might increase the financial return to STM relative to CL: discount rates, future price increases, incremental growth rates for timber volume, and property rights.

*The discount rate*
One 'price' of potential importance for the SFM vs CL debate is the discount rate. For the financial perspective the relevant discount rate is that of the logger or concessionaire. For the national perspective, the relevant rate is the social discount rate. The two rates can be expected to differ, with the social rate being below the private rate (Pearce, 1986). Surprisingly little is known about discount rates in developing countries. Some evidence exists on discount rates for agriculturists in developing countries. For example, Cuesta *et al.,* (1994) found that real personal discount rates of farmers in Costa Rica were in the range of 15-22%, and they use the finding to cast doubt on the economic feasibility of introducing soil conservation measures. Aylward and Porras (1998) suggest that a social discount rate for Costa Rica generally would be 7-10%, i.e. half the private rate. Nonetheless, the range for the social rate is roughly in accord with the rates that have been used in forest studies in Costa Rica. By far the most comprehensive analysis is by Poulos and Whittington (1999) which covers the general public in Ethiopia, Mozambique, Uganda, Indonesia ,Bulgaria and Ukraine. While not all of these are countries with significant forest, they are typical of the range of forested countries. Poulos and Whittington find that short-term personal discount rates are 45-206% and longer term rates are11-28%. The long term rates are very consistent with the Cuesta, *et al.,* (1994) study in Costa Rica. Rates this high would make it difficult to justify even the most conventional of development projects. In the context of forestry they are effectively fatal for any investment with a long-term focus.

The importance of the discount rate can be illustrated by Figure 3. There a hypothetical flow of profits from CL and SFM is illustrated with the typical 'hump' of returns under CL occurring early on. Annex 1 shows how the 'switching' discount rate can be found, i.e. the rate which would make the NPV of the two profit streams the same[3]. While high personal discount rates appear to be the norm on the basis of the empirical evidence, it is important to stress that few studies exist that adopt rigorous methodologies for estimating those discount rates. Additionally, some poor communities do manage timber production on a non-exploitative basis, suggesting that communal discount rates may be markedly less than purely personal rates (see Pinedo-Vazquez and Rabelo, 1999, on varzea logging).

[3] Figure 3 assumes a constant discount rate over time. In practice, discount rates may vary with time due to changes in personal circumstances.

**Figure 3: Typical pattern of profit flows from CL and STM**




*Timber prices*
If timber prices are expected to appreciate then there is some benefit to curtailing cuts now in favour of the future (effectively, price increases can be thought of as a deduction from the discount rate). But future timber prices are unlikely to grow rapidly. Some of the high price increases simulated in the STM studies, e.g. Howard and Valerio (1996), are based on protected forest industries. World prices are a better guide. Moreover, world price ('border prices') would be the relevant magnitude in economic, as opposed to financial, studies. Rice *et al.,* (1998) use 2% p.a. growth in real prices which may, however, be an exaggeration of future price increases. Work at Resources for the Future (Sohngen *et al.,*1997) suggests baseline price growth rates well under 1% p.a. for the next 100 years. Even with a high demand scenario, price increases barely exceed 1% per annum over the next 60 years. These results are consistent with other estimates of long term trends – e.g. see Brooks *et al.,* (1996). Overall, it seems unlikely that future price increases will confer significant advantages on STM relative to CL. More generally, as long as timber is 'abundant', stumpage prices will be low, making STM financially vulnerable (Southgate, 1998).

*Timber volume growth rates*
Timber volume growth rates have an effect similar to real relative price increases. If growth rates are faster under STM then the difference can be regarded as the

equivalent of a reduction in the discount rate. Rice *et al.,* (1998) suggest 2% p.a. as an average for growth relevant to STM, i.e. 2% per annum in volume of the stand. However, quotations of percentage growth rates are not very meaningful. First, growth depends on stand condition such that growth is an inverse 'U' shaped curve relative to stand condition (low at poor states and low again if there is high density and crowding, although the latter is rare in managed natural forests) – see Vanclay (1994). Second, large trees may have small percentage growth rates but substantial incremental yields in terms of cubic metres of wood. Third, account has to be taken of damage in CL to residual trees (10-40 cm dbh) that will form the next crop in polycyclic management operations. Surviving damaged trees grow slowly and will not contribute to the next commercial crop due to stem defects. Most of the growth benefit from RIL and STM derives from higher stocking and fewer weed dominated areas, such as vine blankets.

Overall, STM could easily result in volume increments of commercial species that are 2-4 times higher than after CL.

*Property rights*

It is widely argued that insecure or short-term property rights encourage CL, so that longer-term rights would encourage a switch to SFM, or at least STM. Rice et al. (1998) accept the argument in principle but argue that longer-term concessions would not alter the underlying financial costs and benefits, favouring CL. But tenure might also encourage better environmental choices of equipment and the training of staff, or at least enable better choices to be made. Boscolo and Vincent (1998) simulate the effects of longer-term concessions on the timing of harvests in Malaysia and show that, on their model, it would make no difference. Generally, it does not pay to leave trees standing[4]. Probably the best way to accommodate the concession length issue is to regard longer concessions as an *enabling* device for STM which, without additional incentives such as performance bonds, will nonetheless be unlikely to lead to STM.

*Efficiency and best practice*

One remaining issue concerns the extent to which the STM systems observed in Table 1 reflect 'best practice'. That is, what is being observed may not be the most efficient form of STM, making cost comparisons misleading. Various in-efficiencies need to be addressed: (a) ratio of usable wood to cut wood; (b) ratio of

[4] The issue of concession length needs to be distinguished from the issue of allocating rents where rent equals the difference between delivered log price and marginal cost, or, more correctly, the difference between price and marginal social cost. It has often been argued that rents should be taxed more heavily to discourage rent-seeking by loggers. But this is an issue of desirable distribution of rents, not of efficiency. Efficient solutions are not affected by the division of the rents between stakeholders. See Hyde and Sedjo (1992), Vincent (1993) and Hyde and Sedjo (1993).

cut wood to wood at the mill gate, (c) ratio of mill output to mill input. Do (a) and (b) vary by type of management regime? How do loggers respond to efficiency improvements (and why don't they adopt them automatically?). Part of the problem seems to be that critics are damning STM as it has been practiced. Defenders of STM and SFM are saying that past systems were poorly implemented, e.g. by excessive canopy opening, inappropriate log transport, inappropriate machinery, lack of training and planning, etc. In other words, we need to know what would constitute an efficient system.

But what constitutes efficient STM or SFM may be rather like the Holy Grail, since efficiency implies an agreed objective and the reality is that no such consensus exists. Objectives might, for example, embrace recreating the original stand, regenerating harvested species, conserving 'habitat' trees, minimising gaps, and so on. The reality seems to be that SFM is itself an 'elastic' concept, making the criticism that it has not been practiced when it should have been, difficult to evaluate.

*Valorising non-commercial timber species*

It has been argued that 'valorising' non-commercial timber stock will provide less incentive to use regimes that damage residual stands (Buschbacher, 1990). Rice et al (1998) argue, on the other hand, that expanding the commercial range of species simply results in all species being exploited. The reality is complex and depends on prices for such species, supervision and what the management regime is trying to achieve. In Queensland, the valorisation of species took pressure off the best and most accessible areas, and good supervision of the operations meant that the additional species harvested did not result in degradation of the residual stand (Vanclay, 1996). But it is hard to generalise on the valorisation issue.

*7.2.7 Concessionaires and confidence*

Sustainable forest practices involve having confidence in the long term future. Many of the world's most valuable forests are in areas where there is a potential for rapid political change and the insecurity that it engenders. The effect of lack of security will be to reduce confidence in the future and hence to favour short-run exploitation. The effect is the same as that of a high discount rate.

## 8. The National Perspective

The national perspective on land use options differs from the financial analysis outlined above in several ways. First, logging may not be the 'best' use of the forest land, so that the options on land use broaden to those set out in Figure 1. Second, attention now has to be paid to the *sequencing* of land use. Figure 1 suggests one possibility is that logging is followed be either protection or conversion (and to which we might add abandonment). Which one follows will determine the flow of costs and benefits to the nation.

Third, financial gains and losses should no longer be as relevant as economic gains and losses, i.e. financial flows should be shadow priced. Fourth, all forest values other than timber values become relevant.

We address each modification in turn.

### 8.1 Widening the options to all forest land uses

Figure 2 shows a set of alternative forest land uses. In practice there will be combinations of uses that should also be considered, e.g. agro-forestry, clearance for plantation forestry, oil palm, etc. But the principle is the same, whereas a private logger might reasonably consider only the financial costs and benefits of logging options, the nation state should consider all options and evaluate their economic value.

### 8.2 Sequencing of land use

Surprisingly little attention appears to be paid in the CL 'vs' SFM debate to the sequencing issue. It is well known that logging opens up frontier land which may then be colonised by agriculturists[5]. Repetto (1990) is of the view that most deforestation arises from the initial action of logging which creates access to hitherto inaccessible forest land. In their review of econometric studies of deforestation Kaimowitz and Angelsen (1998) find that deforestation is higher when land is accessible, when timber and agricultural prices are high (encouraging logging and conversion), when rural wages are low and when there are opportunities for long distance trade. Of these factors, several – accessibility, timber prices, and trade potential – all relate to logging. Southgate (1998) documents cases where most road construction in forested areas has come from loggers, encouraging conversion to cropland and pasture. Low stumpage prices might contribute to conversion since even the modest rates of return that might be expected from agriculture compare favourably to forestry at low stumpage prices.

This picture contrasts with the one suggested by some analysts who argue that CL *could* be followed by outright protection (Rice *et al.,* 1998a; Rice et al 1998b; Cannon *et al.,* 1998). The argument here is as follows: loggers are unlikely to return to the same area after the initial logging phase because (a) they do not practice sustainable forestry, thus making future timber stands unlikely to be of commercial interest, and (b) because they have high discount rates, also making

[5] Sequencing may happen the other way round. The land may initially be cleared for agriculture and taking timber may be an ancillary operation aimed at helping recover the costs of conversion.

future yields unattractive. The land is therefore potentially available for protection without the further threat of logging. The argument has some force, but there are several problems.

First, the picture of loggers entering an area only once is often not accurate. Loggers often return 5-10 years after the first harvest to harvest trees that have become commercially valuable because of changes in transport infrastructure, in milling methods and market potential. The later phase, re-entry loggers may also be different people to the first-time entrant: smaller operators with lower operating costs acting as agents for small mills working in formerly high graded areas. The 'protect after logging' scenario thus has to relate to a context in which the threat of subsequent logging interventions remains.

Second, even if the threat of further logging is removed, the threat of colonisation for non-timber purposes is not removed and, indeed, is, *ex hypothesi*, more likely. Colonisation here may be for subsistence agriculture but also for far more attractive agro-industrial use such as oil palm. Additionally , the 'logging followed by protection' view is based on what could happen rather than on what actually has happened in the past. However, there is an argument that says protection is easier after CL because land prices fall once loggers withdraw. Land can then be bought cheaply for protection purposes.

Third, CL may result in such significant degradation that what is left is not worth protecting. Substantial opening of canopies results in increased susceptibility to fires and increases in the likelihood of weed infestations. A spiral of degradation soon becomes irreversible.

Conventional logging followed by protection has indeed occurred, for example in Queensland, in the Noel Kemp Mercado carbon offset project in Bolivia, and in parts of Africa. But how far these examples arise simply because there were funds available for subsequent protection and because there was low population pressure on available land is unclear. Indeed, it is hard to envisage many circumstances in which there will be limited pressures to convert the land. The choice is then not often between 'logging followed by protection' and SFM/STM, but between some form of continuous forestry and land conversion. The potential for logging to be followed by protection may therefore be smaller than some of the literature acknowledges, although Reid and Rice (1997) accept that STM will be best suited to areas where there are strong pressures to colonise the forest for conversion. And, of course, protection is costly and in no way avoids the need for continued management.

One other form of sequencing has strong arguments in its favour. Here the aim would be to meet timber demand from plantations, leaving natural forests to be managed mostly for non-timber purposes. The sequence is then to afforest rapidly to establish plantations on degraded lands, accepting some loss of natural forest in the interim, then declaring the remaining natural forest to be protected whilst meeting demand for timber from plantations. Hunter (1998) describes this situation for New Zealand. That such a policy works for New Zealand, and has been suggested in the USA where some environmental groups are calling for cessation of all logging on in National Forests, carries the suggestion that this option is best for countries with relatively high levels of per capita income. A country like Malaysia, where there are already extensive lowland plantations, could adopt such a policy, but lower income countries are still likely to face formidable pressures for conversion of natural forest, so that finding profitable forest management systems is still important[6].

Again, it needs to be recalled that protection is not costless. Not only are there continuing management costs, but there are capital costs of fencing and management institutions. To these must be added the value of the protected land in its forgone use(s).

### 8.3 Shadow pricing private costs and benefits

The analyses of costs and benefits to loggers have typically all been in terms of financial rather than economic flows. Exceptions, noted in Table 2, are the World Bank studies reported by Grut (1990).

### 8.4 Allowing for non-timber values

Allowing for non-timber values of the forest alters the focus of analysis from STM to SFM. In economic language, the relevance measure is now *total economic value* (TEV) from the different possible land uses. TEV comprises use and non-use values and both are capable of expression in monetary terms by estimating the relevant *willingness to pay* (WTP) for those functions (Pearce, 1993, 1996).[7] The basic argument is that, even if STM is 'worse' than CL in financial terms, if the WTP for the incremental non-timber benefits of SFM exceeds the financial deficit, SFM will be preferred from a national perspective. More formally,

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[6] The New Zealand and Malaysia examples raise the interesting issue of whether there might be an 'environmental Kuznets curve' (EKC) for forest protection. EKCs exist when growth in income per capita first results in environmental degradation and then, after some turning point, a reduction in degradation. Such curves have been found for air pollution. In the current case, the hypothesis would be that countries opt for more forest protection and more plantations as incomes pass a certain point.

[7] It is important to understand that all 'prices' in economics reflect willingness to pay. Some commentators limit WTP to expressions of WTP derived from questionnaire surveys. This is not correct. All market prices, for example, reflect the WTP of consumers for the product in question.

$SFM > CL$, if $WTP_{ntv} > \Pi_{cl} - \Pi_{stm}$ ….[1]

Where 'ntv' is non-timber values and Π is profit.

Bawa and Seidel (1998) say there is no experience of timber regimes that integrate NTPs into the management system, but this does not square with Putz (1992), or with empirical experience from Costa Rica (Romero, 1999) and Nicaragua (Salick, 1995). Romero (1999) found that RIL had no effect on the available biomass of epiphytic bryophyes that are harvested and sold by local people. Similarly, Salick (1995) found that NTFPs and natural forest management for timber were compatible in Nicaragua. In small scale natural forests integration of NTFPs with timber is more the rule than the exception (see Pinedo-Vazquez and Rabelo, 1998). However, Putz *et al.,* (1999) note that management invariably involves favouring some wildlife species over others.

*The evidence on environmental impacts of logging regimes*

The presumption in inequality [1] above is that environmental benefits under STM/SFM exceed those under CL. This has been challenged by Rice et al (1997, 1998a, 1998b). They argue that the physical effects of CL on the forest were relatively mild for the case they studied in lowland Bolivia. However, that case relates to extremely low intensity mahogany harvesting, and it would be hard to envisage that it would also hold for the much more intensive harvesting characteristic of the eastern Amazon, or the dipterocarp forest of southeast Asia. Rice *et al.,* (1998) and Reid and Rice (1997) argue that STM/SFM can be just as destructive of the total forest as CL, a view supported by Bawa and Seidler (1998). Uncontrolled logging, it is argued, may be comparatively benign, especially on flat lands that are logged when soils are dry and where there is a low density of commercially exploitable species. Without the prior topographical, soil trafficability and density conditions, however, CL may be very destructive. STM can be destructive if it involves major canopy clearance in an effort to encourage regeneration of light demanding species, but much depends here on the management system in place (see below).

Extrapolation from single site studies, however, is dangerous. Manokaran (1998) describes the effects of selective logging in Pasoh, Malaysia. Contrary to statements that no selective logging system has been successful (Rice *et al.,* 1998), Manakoran finds that the Malayan Uniform System (MUS) of selective cutting in the 1950s successfully regenerated the basal area of primary forest which, by the mid 1990s, was well stocked with commercially valuable dipterocarp species. He contrasts this with the far less successful selective management systems (SMS) being practised in the hill forests. Moreover, the Queensland experience of over one hundred years of logging and close to SFM also suggests that selective logging can be successful (Vanclay, 1994, 1996).

***Biodiversity***

Part of the problem with the discussion on environmental impacts concerns the characterisation of the environmental objectives of forest management. Whereas Rice *et al.,* (1997) talk primarily in terms of the maintenance of biodiversity, others would argue that what matters is the maintenance of ecosystem functions and ecological processes. Some of the concern about avoiding management-induced changes in tropical forest composition is based on the concept of 'climax communities', and the idea that tropical forests are unchanging and lacking in resilience. Given the long history of substantial human impacts on tropical forests and the large areas of tropical forest currently under some sort of silvicultural management by people, the incompatibility of management for timber with bio-diversity maintenance seems largely unfounded. For example, many researchers have reported that stands with mahogany almost certainly suffered severe natural disturbances in the past, or regenerated in agricultural clearings that were abandoned centuries ago. Despite this evidence for ecological resilience, much more research is needed on how to mitigate the deleterious impacts of forest management operations. For example, how should untreated reserves be distributed within managed forests, and is it preferable, from a biodiversity maintenance perspective, to concentrate or disperse logging operations?

But even at the level of biodiversity the issue is far from clear cut. First, all forest management is likely to reduce biodiversity relative to pre-intervention conditions, or at least to change species composition. The very term 'management' means that something is being done to the forest that would not have happened without intervention. Second, the issue then becomes one of comparing the biodiversity profile – i.e. the nature and extent of diversity - under the different management regimes, say SFM and CL. Thus, Rice *et al.,* (1998b) make a biodiversity conservation argument in favour of introducing protection after logging has taken place. They suggest that even CL followed by protection is superior to STM/SFM because the former halts the process of forest domestication But this is a double edged argument, for CL could just as easily result in the loss of species dependent on large canopy openings or for regeneration pioneer species. Certainly, CL stands are especially prone to weed infestations due to excessive damage and lack of pre- or post-logging treatments to discourage weeds and encourage potential crop trees. Even though it does not constitute STM or SFM, reduced impact logging (RIL) would be a substantial step in the right direction. Thus, pre-felling vine cutting can substantially reduce post-logging incidence of serious vine infestations, and also reduce logging damage where vines tie together tree crowns. RIL thus constitutes a major step forward.

Additionally, there has been a tendency to generalise from single area case studies. The work of Rice *et al.,* relies heavily on observations in the dry forests of Northern Bolivia where, if sustainable timber exploitation for the species currently harvested is to be practiced, substantial canopy manipulation is required in order to provide the conditions for the regeneration of light-demanding species, especially Swietenia macrophylla. The structure and composition of the forest would thus have to change in a substantial way to avoid loss of the currently most valuable species of canopy trees. Even for these forests, it is unclear that species loss due to management need be significant. These forests have survived major disturbances in the past, and proper zoning of the forest should ensure biodiversity is retained.

Not all commercially valuable timber tree species require substantial canopy disturbance for regeneration. In southeast Asia dipterocarp forests, for example, minimising damage to residual stands is important to protect the abundant advanced regeneration of commercial species present before harvesting and to reduce the likelihood of vine infestation once the canopy is opened. The valuable canopy dominants in the forests of much of the Guyana Shield area in northern South America are also negatively affected by the substantial canopy openings required to regenerate mahogany in northern Bolivia.

Thus, it is not possible to say that STM systems necessarily result in less biodiversity than CL systems. Without careful management, they may do so. If one of the aims is to conserve biodiversity then management systems should be capable of achieving that aim. In doing so, it may well be the case that the financial returns to STM fall since there will often be a trade-off between biodiversity objectives and maximum financial return. Given that biodiversity conservation figures prominently in Forest Stewardship Council certification, any price or marketing gains from certification will also reduce the profit differential between CL and SFM.

An interesting study by Stephens (1999) in South Australian *Eucalyptus regnans* forests shows that conservation strategies for Leadbeater's possum are best effected through forest reserves, with a close running second best approach being modified harvesting regimes, and with both strategies being preferred over longer rotations. 'Best' and 'better' in this context are measured by the survival probability of Leadbeater's possum (the 'effectiveness' of the strategy) and the forgone timber values (the cost). The modified harvesting regimes involved the retention of small habitat patches within harvested areas, suggesting, again, that careful logging is consistent with biodiversity protection.

***Carbon***

Forest-based carbon sequestration, both by conserving carbon already stored in forests and by sequestering additional carbon by stimulating tree growth, has become an important focus for foresters because of the role that forest carbon release plays in accelerating global warming. This role was given official recognition in the 1997 Kyoto Protocol to the 1992 Framework Convention on Climate Change. Countries can benefit in terms of achieving their emission reduction targets by engaging in 'carbon trades' whereby they offset some of their own emission targets by reducing net emissions in another country. The issue here is how different management regimes affect carbon storage.

Silvicultural practices affect carbon balances. Thus, if vines are cut and left to decompose, carbon is released in the short term from the decomposition process, but can be offset later by the faster growth of the trees that are now free of the vines. SFM, practised properly, involves minimum site preparation and extended rotations, whereas clear cutting results in loss of necromass and soil organic matter which may well not be offset by subsequent sequestration through faster tree growth. In general, then, silvicultural practice benefits the carbon balance. Exceptions might include savannah woodlands (e.g. the pine forests of Central America) that are invaded by shade tolerant and less fire resistant trees. Restoring the open stands will result in carbon releases that may not be compensated for by increasing sequestration in the remaining trees.

Dixon (1997) conducts a survey of experience with silvicultural practices in forty countries. Dixon's results are shown in Table 3. The analysis suggests that silvi-cultural practices can result in additional sequestration or conservation of carbon ranging from 5tC to 41tC depending on latitude. Dixon suggests that if these practices were applied to the 600 million ha of land suitable for forest management in the nations surveyed, conservation of carbon would be of the order of 100-300 mtC p.a. over a 50 year period[8]. The economic efficiency of such measures is unlikely to compare favourably to the costs of reducing green-house gas emissions through energy-related schemes, or from plantations, but Dixon suggests that the practices in question could sequester carbon at some $13 tC. This is lower than the $20-30 tonne often quoted.

[8] For reference, global emissions of CO2 are some 6.2 billion tC, so that the potential from improved silvicultural practice amounts to 1.6% to 4.8% of world emissions.

**Table 3: Dixon's survey estimates of incremental carbon sequestration from silvicultural practices**

| Latitude | Practice | $TCha^{-1}p.a$ |
|---|---|---|
| *High 60-90$^o$* | Fertilisation | 1-16 |
| | Thinning | 3- 7 |
| | Weeding | 1- 3 |
| | Drainage | 3-11 |
| | Median value | 5 |
| *Mid 30-60$^o$* | Fertilisation | 2- 28 |
| | Thinning | 15-65 |
| | Weeding | 8- 34 |
| | Median value | 22 |
| Low 0-30$^o$ | Fertilisation | 26-71 |
| | Thinning | 18-64 |
| | Median value | 41 |

Source: Dixon (1997).

In comparative simulations of carbon sequestration in Malaysian forests logged by trained crews following RIL guidelines and with CNV methods, Pinard and Putz (1996) (see also Boscolo and Vincent, 1998, which adopts the Pinard-Putz estimates) showed that the use of RIL techniques conserved carbon in the harvested stands and resulted in substantially greater rates of post-harvesting sequestration due to higher stocking of potential crop trees and fewer problems with vines and other weeds.

An interesting study by Solberg (1997) suggests that if carbon is valued at $50 tC, approximately the level of the Norwegian carbon tax, the value of Norwegian forests would increase by 2-30 times the value of timber output. If forests are managed according to their mixed timber and carbon value, as opposed to their timber value alone, significant changes would need to occur in management practices. Standing volumes and rotation ages would need to be increased, and there would need to be substantial increases in investment in silviculture. Leakage issues would loom large under such a scenario, given the large and growing international demand for paper and other wood fibre products. With long rotations, natural forest succession would occur which, in some cases, would reduce the attractiveness of forests for early successional species of plants and animals, as well as for recreation, so some of the 'carbon gains' would be offset by other factors. Despite these misgivings, the clear implication is that the attachment of economic values to carbon via trading and/or meeting domestic emission reduction targets could substantially favour better managed forests[9].

Numerous 'carbon offset' projects exist either in actual or simulated form (simulations often involve actual projects which are not primarily designed to reduce carbon emissions, but which are being 'tracked' to see if the carbon benefits would make a significant difference; other simulations exist that are not associated with particular projects). Details of the various deals and their costs per tonne of carbon reduced can be found in Pearce *et al.,* (1998). Few of the deals relate to forest management. The offset projects can be analysed to elicit the average costs per tonne of carbon equivalent reduced. However, since the deals have not generally been developed on a cost efficient basis (selecting the cheapest options first) such an analysis is not particularly helpful. Estimates of the prices at which carbon will trade under the 'flexibility mechanisms' in the Kyoto Protocol do, however, suggest that around $10 tC is likely to be a mean price, provided substantial trading takes place. As the USA is committed to meeting some three-quarters of its Kyoto target by trading (US Administration, 1998), and the European Union has recently announced that it may permit up to 50% of its own target to met from trading, the market could be substantial. A suggested guideline is that carbon may trade at between $5 and $15 tC. The importance of these figures can readily be seen. For forest conservation as a whole, compared to conversion, forests may secure a carbon 'credit' of $75o to $2250 per hectare on this basis[10]. For the comparison between SFM and CL, of course, the gains would be far more modest. If Dixon's figures (Dixon, 1997) are adopted, incremental gains over CL may range from 5-41tC, or $25 to $615 ha.

However, great care needs to be taken in multiplying carbon storage or sequestration estimates by unit money values for traded carbon. The procedure is correct if the price of traded carbon is an equilibrium price, i.e. one that equates supply and demand for traded carbon. That price will be sensitive to the number of deals done. If there are vast 'offers' of carbon from countries seeking to capitalise on the carbon value of sustainable forestry, it may have the effect of forcing the price of carbon down, thus reducing the economic returns from carbon conservation. These 'system wide' effects have been stressed in a number of studies, e.g. Sohngen *et al.,* (1998).

*Willingness to pay for certified timber*

There are two approaches to securing an economic measure of the value of non-timber forest values. The first rests on what people are willing to pay for timber

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[9] But for a sceptical view see Smith et al. (1999b).

[10] Assuming 50tC to 150tC is emitted by conversion. See Annex 3.

certified as coming from 'sustainable' forests, the idea being that 'sustainable' timber embodies all non-timber values in some premium over the world price for timber. The second attempts directly to estimate the economic value of the various forests functions independently.

If consumers of wood products are willing to pay a premium to guarantee that the forests supplying the products are sustainably managed, then that willingness to pay can be thought of as an approximation of the WTP in equation [1] above. Similarly, if forest companies are willing to adopt sustainable practices in order to secure some marketing gain from certification, then the costs of certification provide a lower bound of the additional value of certification.

Certification schemes exist to guarantee the sustainability of various forests, akin to 'eco-labelling' of various products. Various certifying bodies are accredited by the Forest Stewardship Council (FSC) and 3.5 m cubic metres of certified timber entered international trade in 1996, whilst 10 million ha of forests has been certified by 1998 (Crossley and Points, 1998). Certification costs are around $0.2 to 1.7 per ha for developing countries (Crossley and Points, 1998) and 9-12 cents per acre for assessment and 1-3 cents per acre per annum for licensing and auditing in the USA (Mater *et al.,* 1999). Accordingly, any WTP above this level of cost represents the 'net premium' for SFM.

The evidence on the premium consumers are WTP for certified timber is mixed. A survey of four studies in Barbier *et al.,* (1994) revealed the following:

*(1)* a survey of UK *manufacturers* in 1990 suggested 65% were WTP more for certified timber;
*(2)* a survey of UK *consumers* in 1991 suggested a 13-14% premium WTP
*(3)* a survey of UK *consumers* in 1992 indicated that 58% would not buy timber if they knew it came from rainforests, and
*(4)* a 1992 survey of *timber importers* suggested that 70% thought their customers were not willing to pay for certified timber.

An additional survey in British Columbia suggests that 67% of respondents to a survey would pay 5% more for certified timber, and 13% said they would pay 10% more (Forsyth et al, 1999).

Crossley and Points (1998) suggest that certified products are securing premia of 5-15% in some cases, but that the real benefits of certification for industry lie in securing greater market share and longer term contracts. There is some evidence that companies gaining certification secure higher company value, i.e. the value of certification shows up in share prices on the stock exchanges.

If we take the 5-15% range as a likely measure of premium, the argument in Gullison (1995) and Rice et al (1997) is that this is far from sufficient to compensate for the additional profitability of CL over SFM as shown in Table 2. But their argument is suspect. Table 2 suggests that a typical ratio of *financial profits* for CL relative to STM would be, say, 1.5. For STM to become competitive it is not necessary for *prices* to rise by 50%. A hypothetical numerical example should suffice to show that the price premium need only be a fraction of the difference in profits between CL and STM. If costs of CL are 75 and those for STM are 100, but both face the same market price of 150, then the ratio is 75/50 = 1.5, similar to that found in Table 2. The net price premium that will make profits equal is given by

$p^* = (C_{ST}-C_{CL})/P$

where P is the common log price. In the numerical example, p* = 17% (25/150), which is considerably different to 50%. It is true that this premium is gross of certification costs, so that the true price premium required for parity between profits in the two regimes is higher than 17%.

*Willingness to pay for non-timber products and services*

A more direct approach is to seek the willingness to pay people express for the particular non-timber products and services from forests. We review what is known about these WTPs. But note that they need to be applied to the *differential flow* of environmental products and services from SFM as opposed to forests that are just logged. The total values would be relevant if all such services were lost, as they might be from forest conversion. The differential values are relevant for the CL/SFM comparison. The importance of this distinction is that we know a reasonable amount about the economic value of forest services, but, apparently, little about the differential flows of those services according to different forest management regimes.

Environmental economists have made great progress in eliciting economic values for forest products and services. Recent surveys include: Godoy *et al.,* (1993), Pearce and Moran (1994), Gregersen *et al.,* (1995), Lampietti and Dixon (1995), Southgate (1996), Chomitz and Kumari (1996), Pearce (1998), and Pearce et al (1999). The Gregersen *et al.,* study is not comprehensive and tends to exaggerate the problems of applying valuation techniques, whilst some of the others are already dated[11].

[11] IFF(1999) also reviews valuation in the context of forests but the review is rather limited in scope.

There are of course substantial difficulties in reaching general conclusions from WTP studies, primarily because appropriate guidelines for carrying out such studies, such as those set out in Godoy *et al.,* (1993) and Godoy and Lubowski (1992) have not been followed. The result has been a mixture of legitimate and illegitimate valuation procedures. The types of mistake made have included generalisation from studies of a small area of forest to wider areas, with little regard for (a) the fact that the area in question will not be typical of the whole forest area simply because of variations in distance to market, and (b) ignoring the fact that, in a hypothetical world where the whole forest was exploited for non-timber products, the prices, and hence the profitability, of non-timber production would fall. Another methodological issue is the extent to which values are based on maximum sustainable yield or on actual harvests, which are often very much less, i.e. the values that emerge are sensitive to what is assumed about the management regime in place. Godoy *et al.,* (1993) also point out that some studies value the stock and some the flow, the former being an interesting measure for wealth accounting but of little value when comparing competing land use values. Studies also vary as to whether they report gross revenues or revenues net of labour and other costs. Finally, little account has been taken in many of the studies of the extent to which the relevant non-timber activity is itself sustainable, so that what is being compared may well be two non-sustainable land use options.

Annex 2 provides an overview of what is known about non-timber values based on WTP studies. Extracting some kind of consensus from the estimates in Annex 2 is clearly hazardous. We can speculate on the following annual values but care needs to be taken in generalising any of these numbers (Southgate *et al.,* 1996):

| | | |
|---|---|---|
| Non-timber extractive Values: | $ | 50 ha |
| Non-extractive: | | |
| recreation | $ | 5 - 10 ha |
| ecological | $ | 30 ha |
| carbon | $ | 600-4400 ha |
| Non-Use | $ | 2 - 27 ha |

Whichever way the analysis is done, the major role of carbon values is revealed. Should, for some reason, global warming not remain a serious issue of concern, then tropical forests might be found to have measured environmental value of around $100 per hectare, far from enough to justify outright protection on economic grounds.

*Kumari's study for Malaysia*

One of the few studies that attempts to place an economic value on the differential flows of goods and services from CL and SFM is Kumari (1995, 1996) for the peat swamp forests of North Selangor in Malaysia. The analysis relates to the differential benefits of moving from an existing unsustainable timber management system, based on Malaysian Stateland forest practice, to sustained forest management overall. Various degrees of sustainability are addressed to allow for the trade-off between sustained timber and non-timber products and services. The results are shown below.

**NPV 1990 US$/ha at 8% discount rate**

| | **Unsustainable CL** | **Sustainable option 1** | **Sustainable option 2** | **Sustainable option 3** |
|---|---|---|---|---|
| Timber values | 1380 | 944 | 700 | 510 |
| Local/national non-timber values | 251 | 308 | 447 | 563 |
| Global values | 3356 | 3645 | 3658 | 3668 |
| Total | 4987 | 4897 | 4805 | 4741 |

Notes: assumes 20% damage case. Kumari (1996) also estimates NPV for a 50% damage case. M.ringits converted to $ at 2.5 R per $. Option 3 is more sustainable than 2, 2 is more sustainable than 1.

*Assuming constant damage from logging across all management schemes*, CL would be preferred to each of the sustainable options, although the uncertainty in the approaches used to value the impacts is such that the statistical significance of the differences shown above is unlikely to be high. However, Kumari (1996) argues that the damage rate will be much higher, at 50%, for the least benign forms of timber extraction, the first two columns above. In that case the total damages would change as follows:

| | | | | |
|---|---|---|---|---|
| Total | 4092 | 4252 | 4805 | 4741 |

The sustainable systems are now markedly better than the unsustainable systems. The 'best' sustainable system shows a 13% improvement on the 'best' unsustainable system.

The national non-timber benefits comprise rattan, bamboo, recreational and water benefits, together with ago-hydrological benefits because of the regulation of water supplies. The global benefits comprise endangered species and carbon, with the latter being the most important. The economic values shown reflect (a) the difference in unit 'prices' (WTP) applied to the impacts, and (b) the differences in ecological impacts. Taking the 'best' sustainable option (2) and comparing it to the base case of unsustainable management which maximises timber benefits alone, the incremental changes are as follows:

| | Increase in NPV for Option 2 relative to unsustainable base case. NPV 1990 $US/ha |
|---|---|
| Timber | -160 |
| National non-timber | +225 |
| Global | +648 |
| Total | +713 |

Whereas timber benefits decline, as would be expected from the analysis in Table 2 of this analysis which shows relative profitability of timber from different regimes , non-timber and global benefits increase more than enough to offset the losses.

How typical this analysis is for forests generally is of course open to serious question. In this case, for example, the agro-hydrological benefits account for about two-thirds of the national non-timber incremental benefits, rattan accounting for the rest. The fairly dominant role of carbon is borne out by the review in Annex 2, even though Kumari uses different (and lower) carbon values. Additional questions arise with respect to the economic analysis itself since it uses several 'benefits transfer' estimates (essentially, borrowing WTP figures from other studies). It is known that benefits transfer is subject to significant margins of error. Most importantly, the global benefits will not accrue to forest owners or concessionaires without institutional change which compensates them for storing carbon in the biomass. Existing carbon trades, and those expected under the Kyoto Protocol, thus become extremely important. In essence, Kumari's analysis provides the 'demonstration' phase, but not the capture phase of the analysis, as she herself notes.

Nonetheless, Kumari's approach, which is essentially traditional incremental cost-benefit analysis, is the correct one and is likely to be the only one that can capture all the relevant changes in the multiple outputs of different forest management regimes.

*Bann's study for Cambodia*

Bann (1997) reports detailed economic values for timber, non-timber products and environmental benefits for forest land in Ratanakiri, Cambodia. The analysis is interesting since it suggests that, for this case, NTFPs *alone* represent the best use of the forest land, although there is a crucial difference between actual, current rates of collection and those that could be obtained, the latter being based on a full forest inventory. The essential results are shown below (with corrections as there are several wrong totals in the original and environmental benefits are wrongly treated in the summary table).

**NPV at 6% US$/ha**

| | Existing sustainable NTFP collection | Potential sustainable NTPF collection | Sustainable timber | Unsustainable timber |
|---|---|---|---|---|
| NTFPs: | 697 | 3811 | 0 | 0 |
| Malva nuts | | 23 | | |
| Rattan | | 88 | | |
| Bamboo | | | | |
| Environmental benefits: | | | Assumed to be half NTPF scenarios = 297 | 0 |
| Biodiversity | 511 | 511 | | |
| Watershed | 76 | 76 | | |
| Carbon | 7 | 7 | | |
| Timber | 0 | 0 | 408 | 1697 |
| ***Total*** | 1291 | 4516 | 705 | 1697 |

The columns show the net present value of each option. The first column of results shows the existing practice. The next column shows the social benefits if the existing practice was used to full potential. The final columns show sustainable and unsustainable timber regimes.

Bann's conclusion is that the inventory-based NTFP scenario, i.e. utilising NTFPs to the full, would maximise economic returns. Note, however, that if NTFPs are ignored, unsustainable timber is to be preferred even allowing for the higher environmental benefits of the sustainable timber option. The NPV arising from actual collection of NTFPs does not compare with CL either. Bann's conclusions echo those of Peters et al (1989) for the Peruvian Amazon. However, that study has been severely criticised on methodological grounds (e.g. Godoy *et al.,* 1993), and is also not consistent with later work on NTFP yields (Phillips, 1993).

*Shawahid et al., study for Malaysia*
While not a comprehensive study, Shahwahid *et al.,* (1997) and Shahwahid *et al.,* (1998) suggest the interesting finding that RIL forestry in Hulu (Ulu) Langat Forest Reserve, Selangor is preferable to outright protection. Total protection is assumed to have zero timber production, positive water yield benefits and sedimentation protection benefits for a nearby hydro-electric power station. Outright protection results in a NPV of 10.4 million ringits, whereas RIL results in

26.6 million ringits due to the gain in timber production and the limited impact on hydroelectric power.

*Mattsson's study for Sweden*
Mattsson (1994) reports a partial economic valuation study of different timber regimes for northern Sweden. He compares clear cutting combined with artificial regeneration and natural regeneration using advance growth or seed trees. Contingent valuation was used for a sample of 800 people in the county where the forest is located. Respondents were asked their willingness to pay for different landsacpes without being told that the various depictions reflected different silvicultural regimes. Depending on the mixtures of pine and broadleaves, the average willingness to pay for natural regeneration systems varied from about 700 SEK to 3000 SEK per individual per year. Mattsson notes that his findings are consistent with general preference surveys in Sweden which find that people are opposed to clear felling.

*Yaron's study for Cameroun*
Yaron (1999) and Groosman and Yaron (1999) investigate the potential for forest conservation in the Mount Cameroun area. The land use options considered are (a) oil palm and rubber plantations, (b) sustainable forest use and (c) subsistence-oriented agriculture ('chop farms'). Since only one type of forest management option is considered, the analysis does not shed much light on the issue of forest management choice. Nonetheless, it is significant that SFM is economically the preferable option in each of the five regions studies, as shown in Table 4.

The major issue to note is that SFM is not economically profitably if 'direct use values' only are calculated, i.e. if consideration is given only to the marketed produce from the land. This holds even when non-timber products are included. The exception is area 5 where *Prunus africana* is grown in the forest option. Generally, then, non-marketed values are very important. Moreover, within the non-market values, carbon dominates, a result consistent with the review carried out by Pearce (1998).

**Table 4: Net economic returns to SFM in Mt Cameroun area over and above next best use of the land (NPV in UK£ per ha at 10% discount rate)**

| | **Area A** | **Area B** | **Area C** | **Area D** | **Area E** |
|---|---|---|---|---|---|
| *Next best use* | *Chop farm* | *Chop farm* | *Chop farm* | *Chop farm* | *Chop farm* |
| Direct use value | -884 | -790 | -271 | -521 | +1537 |
| NTFPs | +8 | +15 | +14 | +14 | +14 |
| Carbon | +971 | +971 | +1090 | +864 | +981 |
| Medicinal plants | +1 | +2 | +2 | +2 | +2 |
| Flood prevention | 0 | +120 | +136 | +168 | 0 |
| Preventing sedimentation | +8 | +7 | +11 | +3 | +65 |
| NUV | +62 | +62 | +62 | +62 | +62 |
| Total | + 166 | +387 | +1046 | + 591 | +2661 |

Source: Yaron (1999)

Notes: NUV = non use value, see Annex 3. NTFP = non-timber forest products. Direct use value = revenues from timber, agriculture or oil palm. No study was conducted for the estimate of NUV and it should therefore be regarded as a guess only. Note that each entry refers to the *difference* in net present value returns from SFM relative to the returns from subsistence agriculture. Thus, area A is worse than subsistence agriculture by UK£ 884 per ha for direct use, but £971 better for carbon.

*Smith et al., Study for Peru*

Smith *et al.,* (1999a) (see also Mourato, 1999) conduct a contingent valuation study of slash-and-burn farmers in the Ucayali region of the Peruvian Amazon. They sought the farmers' willingness to accept compensation simultaneously to conserve part of the forest outright and to switch to multistrata agroforestry for the rest of the forest. Farmers were first asked their willingness to accept (WTA) compensation (from electric utilities engaged in carbon offset projects) for the combined preservation/agroforestry package, and were then asked by how much they would discount the stated WTA to secure access to the environmental services of the conserved part of the land. The difference between the two WTA measures, gives a willingness to pay measure (i.e. in terms of forgone compensation) for the environmental services. The results were, in average terms:

- $218 compensation required for forgoing one hectare of forest that would be converted to outright preservation;
- $138 compensation for forgoing one hectare of forest that would be converted to agroforestry;
- $67 willingness to pay for environmental services for forest preservation
- $41 willingness to pay for environmental services for agroforestry.

The difference between the two WTP estimates reveals that farmers are aware of the difference in the value of environmental services from agroforestry compared to preservation.

The study is significant in that it elicits (a) the compensation farmers would need to fill the 'gap' between the returns to agroforestry and the returns to slash and burn agriculture, and (b) the willingness to pay of farmers for forest services of which they are well aware. The gap between agroforestry and slash-and-burn returns is a perceived one and is highly influenced by farmers' discount rates, i.e. returns are higher to agroforestry over a long period but lower if the time horizon is limited to a few years. Interestingly, stated WTA to switch to agroforestry compared very well with the difference in the annual stream of returns when viewed from this short-term perspective, i.e. farmers were well aware of the returns from different systems.

The relevance of the study lies mainly in the information provided about farmers' perceptions about the forest, but, in so far as agroforestry can be thought of as a form of SFM, it suggests that the social returns to SFM are higher than slash-and-burn provided the 'rest of the world' is willing to pay for carbon services from the forest.

## 9. An Economic Model of Sustainable Forestry

One way of encapsulating the previous discussion is to place it in the context of an economic model of forested land use. Annex 3 outlines a model developed by Hyde (1999) and to which we have added explicit consideration of non-market values. The essence of the analysis is to show the relevance of sustainable forestry in various stages of economic development. Sustainable forestry can only exist if returns to it exceed those of alternative uses of the land *and* exceed the costs of management, including the costs of preventing entry by colonists. Hyde suggests that these conditions will tend *not* to prevail in the earlier stages of development so that, generally, the poorer the nation the less likely it is for sustainable forestry to emerge as a viable land use option. But the analysis also suggests that if non-market values are high, there could be substantial returns from managing forests on a sustainable basis. The additional condition, of course, is that the returns must be capable of 'capture' by the forest owner, whether it is a private individual or the state.

The analysis of Section 8 and Annex 2 suggests that most non-market values will not be high enough to change the underlying and somewhat pessimistic conclusion of Hyde's approach, i.e. sustainable forestry is potentially viable but risky in areas where development is still at the early stages. The fairly clear exception, however, is carbon, and the few case studies that are relevant seem to confirm that carbon values from carbon trading could produce the situation in Figure A3.4 in Annex 3 where a significant sustainable forest sector emerges based on non-market values. Additionally promising is forest certification, depending on the extent to which stated WYP is confirmed by actual WTP.

## 10. Conclusions

In this chapter we have reviewed the available literature in an attempt to cast some light on the issue of the *type* of forest management regime that is best suited to the overall aim of slowing the rate of loss of the world's forests and biodiversity. The traditional argument that 'sustainable forestry' is the most preferred option has recently come under criticism from those who argue that it is neither profitable nor necessarily environmentally preferable to conventional logging.

Finding general conclusions is complex, not least because the terminology in the literature is confusing and often value-laden, even down to regarding 'logging' as an undesirable activity *per se* (Section 3). While not entirely satisfactory, we adopt the language of 'conventional logging', 'sustainable timber management', 'sustainable forest management' and 'protection' (Section 5). The essential differences are that sustainable systems have regard to longer term outcomes than do conventional systems, and that sustainable systems are likely to involve far more regulatory supervision than conventional systems.

The model adopted proceeds from a comparison of financial rates of return to differing forest management systems, through to economic rates of return, and from there to wider rate of return concepts that include non-market values, e.g. biodiversity conservation and carbon storage. There are then at least three stakeholder perspectives on these rates of return: those of the logger, those of the nation, and those of the world as a whole. In reality, there are many different divisions of interest, from those of illicit forest users, indigenous peoples, enforced migrants and so on. The rough benchmark is that forested land should be used for the highest *social* value use, i.e. the use that maximises the broad concept of rate of return indicated above. This notion requires that any values not embodied in the market place be 'captured' through various incentive mechanisms. Those mechanisms - such as debt-for-nature swaps, carbon offsets, green image investments etc., - are not discussed here. The idea of maximising a rate of return also does not embrace the crucially vital question of the *distribution* of gains and losses. While important, these concerns lie outside the scope of this chapter.

The evidence on financial rates of return is surveyed in Section 7.1. While sustainable systems appear capable of earning returns in excess of some 'modest' discount rate (5%, and in some cases 10%), they do not compete financially with other systems. Given the nature of the management process for sustainability, this is not unexpected and conforms with the critics' view of sustainable management.

Are there any factors that mitigate this inequality? Section 7.2 looks at the various arguments that have arisen, from improving concessionaire property rights, to the future of timber prices, and the valorisation of non-commercial species. None appears to give sustainable timber management any edge over conventional systems. All have some role to play, but it is not significant. The evidence on discount rates tends to reinforce the critics' arguments. Recent studies suggest that discount rates in poor countries are very high, indeed, so high that few investments of any kind, let alone in forestry, would seem to be economically justified. But if the focus is on sustainable and unsustainable forest systems, then high discount rates simply reinforce the initial preference for conventional systems based on rapid liquidation of the timber and other resources without regard for future harvests or other impacts.

Some of the critics have argued that logging should be permitted so as to get an initial period of damage over and done with, leaving the way open for protection. The argument rests on some real possibilities that future logging threats are minimised, and land is cheaper once the loggers have gone. Doubts about this argument are raised in Section 8.2: logging once may simply lead to subsequent visits from the same or other loggers; the way is opened up for colonists; and damage may be so extensive that protection ceases to have much of a conservation justification. Sustainable systems are also open to threat since they too open up forests to colonists. The extent to which they will avoid being converted by colonists rests heavily on their financial viability, which, as we have seen, may not be very strong.

The focus therefore shifts to non-market values. Are these higher under sustainable management than conventional logging? Our review in Section 8.4 suggests that they are. It is true that sustainable forestry loses some environmental benefits relative to the pre-intervention period.. But there is no necessary link between sustainable forestry and environmental damage. Part of the problem arises from extrapolating from limited experience, e.g. with mahogany, to tropical forestry in general. This said, research on 'biodiversity impact profiles' is not strong enough yet to reach firm conclusions (Section 8.4.1). For carbon storage, the picture seems fairly clearly in favour of sustainable systems.

The final stage of the analysis asks if these non-timber values are sufficiently important that they outweigh the financial deficit of sustainable forestry when compared to conventional logging. While there is only a limited number of studies to guide us in this respect, those that exist seem fairly uniform in finding that the non-market benefits of sustainable systems are significant. All tend to acknowledge that timber yields are less on a comparative basis but that non-timber values more than offset the relatively lower yield. The role of carbon is highlighted because a survey of non-market values suggests that carbon values dominate the non-market values overall, a conclusion echoed in the case studies reviewed here. Other indirect evidence is also marshalled, e.g. there appears to be a marked willingness to pay by consumers for natural regeneration of forests and for sustainable managed systems.

Finally, Section 9 and Annex 3 place the analysis in the context of a forest model developed by Hyde and extended here. This suggests that the prospects for sustainable forest management is low in the early stages of development, and increases as the values attached to the forest and its services rises over time. Extended to include carbon and biodiversity values, it is arguable that the potential for sustainable forestry is far greater, even in the early stages of development, than might be thought.

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## Annex 1: Discounting

Let the profit from SFM be \$Ys every year. Then the present value of this profit is:

$PVs = \Sigma Ys/(1+r)^t = Ys(1+r)/r$

Let the profit from CL be characterized as an initial profit in the first year of Yu which 'decays' over time at rate d. Then

$PVu = \Sigma Yu(1-d)^t/(1+r)^t = Yu(1+r)/(r+d)$

We can find the rate of discount at which these two profit streams are equal, i.e. the rate of discount at which the land user should be indifferent between SFM and CL. This is given by

PVs = Pvu, or

$Ys(1+r)/r = Yu\ (1+r)/(r+d)$

Such that $r = d.Ys/(Yu-Ys)$

Suppose d = 20%, i.e. in roughly 5 years the logger leaves the area. Let Ys = 0.5Yu, i.e. SFM secures yields *in the first year* of just one half of those from CL. Then, r = 20%. If r>20%, CL is preferred to SFM, and if r < 20% SFM is preferred to CL.

## Annex 2: Non-timber economic values[12]

In their survey of non-timber benefits, Lampietti and Dixon (1995) divide non-timber values into extractive, non-extractive and preservation values. Extractive values involve an actual harvest, e.g. of nuts or rattan. Non-extractive values should be more correctly titled non-extractive use values since they involve use but not harvest of the forest. They include recreation and tourism, but also the indirect ecological functions of forests such as watershed protection and carbon storage. Preservation values are what most now call non-use or passive use values.

[12] It is important to understand that identifying non-timber values is only part of the overall analysis required to establish whether or not such values will contribute to sustainable forest use. Market conditions, macroeconomic policy, property rights etc. all matter. See Pérez and Byron (1999).

*Extractive Values*

Taking extractive values first, Lampietti and Dixon note that most of the studies relate to Central and South America (14 studies out of 20 analysed). Average per hectare values come to $86-101 per annum for Central and South America and $60-65 for Asian countries. The Central and South American results are exaggerated by the Peters *et al.,* (1989) study which has been severely criticised (Godoy *et al.*, 1993; Southgate, 1996). Godoy *et al.,* (1993) report 23 different estimates from studies which only partially overlap with those reported in Lampietti and Dixon (1995). The authors resist the temptation to average the results since they are more concerned to identify differences in methodology and errors as factors accounting for the variation in values. Ignoring the caveats, an average of $50 per hectare per year is obtained (Pearce and Moran, 1994). Some more recent studies suggest higher extractive values. Thus, Adger *et al.,* (1995) report values from just 2 US cents per hectare up to $1537 for te'lom grove (groves in rainforests) management and coffee growing, and around $6 ha pa for pharmaceuticals in Mexico. Bojö (1993) reports extractive values in private woodlands in Zimbabwe of US$39 per hectare. An extensive study by Kramer *et al.,* (1995) of the Mantadia National Park in Madagascar found that villagers would lose around $91 per household per year from forgone forest products (rice, fuelwood, crayfish, crab, tenreck and frogs). This converts to just $3.2 per hectare[13]. In contrast, Houghton and Mendelsohn (1996) find present values of fodder, fuelwood and timber (mainly the first two) of $2200-3600 per hectare for the Nepalese Middle Hills, or around $176 - 288 per hectare in annuity form (at a 5% discount rate).

With regard to pharmaceutical products, the subject of extensive debate, Pearce and Puroshothaman (1995) suggest values of $0.01 to $21 per ha per year, based on established probabilities of finding a successful drug from plant species currently at risk. This assumes a tropical forest area of 1 billion hectares. Ruitenbeek (1989) has rough estimates of medicinal plant value in the Korup forest, Cameroun, which translate to around $0.2 to $0.7 per hectare. Using a very different approach, Simpson *et al.,* (1994) suggest that, taking an optimistic point of view, a pharmaceutical company's willingness to pay would be a maximum of $20 per hectare in Western Ecuador and very much less, perhaps $1 per hectare, elsewhere. Thus, adopting different approaches, these studies produce very low values for pharmaceutical values. Mendelsohn and Balick (1995) suggest a value of undiscovered tropical forest drugs to the pharmaceutical companies of $2.8-4.1 billion. They divide this by 3.1 billion hectares of tropical forest to obtain average values of $0.9 to $1.3 per hectare. The 3.1 billion hectares figures appears to be an

[13] $91 x 351 households = $31,941 across an area of 9,875 hectares = $3.2 per hectare.

exaggeration, whereas the Pearce-Puroshothaman (1995) estimate appears too low. Using a figure of 1.7 billion hectares of total tropical forest, the Pearce-Puroshothaman figures would reduce further to a range of nearly zero to $12.3 per hectare, and the Mendelsohn-Balick figures would rise to $1.6 to $2.4 per hectare[14]. The high values of Pearce-Puroshothaman reflect values to society rather than values to drug companies, i.e. values based on lives saved and the value of a statistical life[15]. The comparable Mendelsohn Balick figure for social values would be around 50 times the private willingness to pay figure. It seems clear that pharmaceutical values will not 'save' tropical forests unless the social value of genetic material is translated into private willingness to pay.

Overall, the conclusions on extractivism appear to be that, in some circumstances, there are high values to be obtained and these may help the case for conservation or sustainable management[16]. Average values have little general meaning but, such as they are, the estimates suggest that $50 per hectare may be a very rough rule of thumb, but there are clearly situations in which higher values can be achieved and others where $50 will seriously exaggerate the net revenues. As a general rule, however, limited faith can be put in non-timber extractive values to save tropical forests. This contrasts with some of the grander claims made in the past (Myers, 1984; Peters *et al.*, 1989). Southgate (1996) warns against the exaggerated view that South American extractivists can live by non-timber products alone - they will invariably deforest as well - and against the assumption that extractivism is inevitably sustainable. Extractivists tend to be poor. Net returns to vegetable ivory collection in Ecuador and rubber tapping in the Amazon basin, for example, tend to be only just above the opportunity cost of labour.

*Non-Extractive Values*

Non-extractive values tend to comprise recreation and indirect ecological functions such as watershed protection and carbon storage. Of these, recreation and carbon storage have attracted the most study.

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14 In contrast, Balick and Mendelsohn (1992) suggest annual net revenues of $19-61 per hectare for Belize.

15 A ‘statistical life’ refers to the value that would be assigned to a single (anonymous) life if each individual’s WTP for a given risk reduction is aggregated over a given population. Thus, if each individual has a WTP of $5 to secure a risk reduction of 0.001, the aggregate value of risk is 5/0.001 = $5000 .

16 We abstract from an alternative argument which would express NTVs as a percentage of household income. Kant *et al.,* (1996) show that household incomes in West Bengal are increased by 20-30% because of income from non-timber products, and that the effect is biggest for the poorest households.

Adger *et al.,* (1995) suggest ecotourism values for Mexican forests of some $8 ha pa, whilst Tobias and Mendelsohn (1991) use the travel cost method to obtain values of $52 per hectare for Monteverde in Costa Rica. One would expect high values for rare ecosystems such as the montane cloud forest of Monteverde. Kumari (1995) estimated a potential recreational value of M$57 ha for her study site in Malaysia, but in present value terms and at 8% discount rate. The cash flows suggest an annual income of about $5 per hectare. For 'conventional' tropical forest, then, values of $5-10 ha might seem appropriate but it has to be stressed that such values are location-specific. Vast tracts of forest will attract no tourist value at all.

Lampietti and Dixon (1995) find a limited number of studies dealing with erosion prevention and which are capable of estimation of benefits on a per hectare basis. Magrath and Arens' (1989) study of soil erosion in Java suggests minimum estimates of damage of $2-7 per hectare. Cruz *et al*'s (1988) study of Philippines suggests $17-28 per ha; Ruitenbeek's (1992) Korup study implies $14 per ha for fisheries protection and $2 per ha for flood control. To these estimates we can add Kumari's (1995) detailed analysis for Malaysia. This suggests hydrological benefits in terms of conserved agricultural output equal to $25 ha pa. Domestic water benefits and fisheries protection would add a further $2-3 in each case. Overall, then, watershed protection functions do seem to have values which cluster around $30 ha pa once a reasonably wide range of functions is considered[17].

Unquestionably the largest value dominating the use values of tropical forests is that relating to carbon sequestration. Lampietti and Dixon's values for this function are too low due to the adoption of somewhat outdated estimates of the marginal damage from carbon dioxide releases. All forests store carbon so that, if cleared for agriculture there will be a release of carbon dioxide which will contribute to the accelerated greenhouse effect and hence global warming. In order to derive a value for the 'carbon credit' that should be ascribed to a tropical forest, we need to know (a) the net carbon released when forests are converted to other uses, and (b) the economic value of one tonne of carbon released to the atmosphere.

Carbon will be released at different rates according to the method of clearance and subsequent land use. With burning there will be an immediate release of $CO_2$ into the atmosphere, and some of the remaining carbon will be locked in ash and charcoal which is resistant to decay. The slash not converted by fire into $CO_2$ or

[17] In contrast, however, Adger *et al*'s study for Mexico suggests just 4 cents per hectare for watershed protection.

charcoal and ash decays over time, releasing most of its carbon to the atmosphere within 10-20 years. Studies of tropical forests indicate that significant amounts of cleared vegetation become lumber, slash, charcoal and ash; the proportion differs for closed and open forests; the smaller stature and drier climate of open forests result in the combustion of higher proportion of the vegetation.

If tropical forested land is converted to pasture or permanent agriculture, then the amount of carbon stored in secondary vegetation is equivalent to the carbon content of the biomass of crops planted, or the grass grown on the pasture. If a secondary forest is allowed to grow, then carbon will accumulate, and maximum biomass density is attained after a relatively short time.

Table A.2.1 illustrates the net carbon storage effects of land use conversion from tropical forests; closed primary, closed secondary, or open forests; to shifting cultivation, permanent agriculture, or pasture. The negative figures represent emissions of carbon; for example, conversion from closed primary forest to shifting agriculture results in a net loss of 194 tC/ha. The greatest loss of carbon involves change of land use from primary closed forest to permanent agriculture. These figures represent the once and for all change that will occur in carbon storage as a result of the various land use conversions.

The data suggest that, allowing for the carbon fixed by subsequent land uses, carbon released from deforestation of secondary and primary tropical forest is of the order of 100-200 tonnes of carbon per hectare.

The carbon released from burning tropical forests contributes to global warming, and we now have several estimates of the minimum economic damage done by global warming, leaving aside catastrophic events. Recent work suggests a 'central' value of $20 of damage for every tonne of carbon released (Fankhauser and Pearce, 1994). More recent work still suggests that this value may be higher at $30 to $40 tC in current price terms (Eyre *et al.,* 1997). Being conservative, and applying the $20 tC figure to the data in Table A.2.1, we can conclude that converting an open forest to agriculture or pasture would result in global warming damage of, say, $600-1000 per hectare; conversion of closed secondary forest would cause damage of $2000-3000 per hectare; and conversion of primary forest to agriculture would give rise to damage of about $4000 - 4400 per hectare. Note that these estimates allow for carbon fixation in the subsequent land use.

**Table A.2.1 Changes in carbon stored with forest land use conversion**

| | Original C | (t/C/ha) Shifting Agriculture | Permanent Agriculture | Pasture |
|---|---|---|---|---|
| Original C | | | | |
| Closed primary | 283 | -204 | -220 | -220 |
| Closed secondary | 194 | -106 | -152 | -122 |
| Open forest | 115 | -36 | -52 | -52 |

Source: Brown and Pearce (1994)

Note: Shifting agriculture represents carbon in biomass and soils in second year of shifting cultivation cycle.

There are problems with these values of the indirect carbon storage functions of tropical forests. First, the estimates of carbon release are uncertain, while the estimates of the economic value of carbon are even more uncertain. The $20 per tonne carbon value is the product of a Monte Carlo simulation so that it encompasses a good deal of the uncertainty about impacts and values, but it does not deal with the potential for surprises or extreme events (Fankhauser, 1995). Second, even if the values are broadly correct and global warming is a 'real' phenomenon, the avoidance of deforestation or investment in avoided logging or forest damage may not be cheapest ways of reducing carbon emissions. The opportunity cost of conservation is clearly the 'development' benefit forgone, i.e. the returns to forest clearance for agriculture, timber or livestock. It seems very likely that these forgone values are indeed very low in many cases. For example, Schneider (1992) reports upper bound values of $300 per hectare for land in Rondonia, Brazil. The figures suggest carbon credit values 2-15 times the price of land in Rondonia. These 'carbon credits' also compare favourably with the value of forest land for timber as implied by the returns in Table 1. If land is worth $300 per hectare in a development use, then the cost of conservation on global warming grounds becomes, say, $3 per tonne carbon ($300 divided by 100 t/ha, say). If the land is worth $2000, then carbon conservation costs $20 per tC. The latter cost is certainly not the cheapest way of conserving carbon, but $3 per tonne could be very attractive. Existing carbon trades under joint implementation initiatives range widely but ‘rule of thumb’ prices centre on $5-10 TCP (*Pearce et al.,* 1999).

*Non-use Values*

The final category of value in the Lampietti-Dixon survey is preservation value, by which is meant passive or non-use value. The only estimate of such value for tropical forests is that of Kramer *et al*. (1994). This reports average WTP of US citizens for protection of an additional 5% of the world's tropical forests. *One time* payments amounted to \$29-51 per US household, or \$2.6-4.6 billion. If this WTP was extended to all OECD households, and ignoring income differences, a broad order of magnitude would be a one-off payment of \$11 - 23 billion. Annuitised, this would be, say, \$1.1 to 2.3 billion p.a. Taking 1.7 billion hectares as the area for total tropical forest, 5% of it would come to 85 million hectares, so that annual willingness to pay would be \$13 to \$27 ha. Obviously, the assumptions being made here are fairly heroic, but they bear comparison with some of the use values identified above, and also pale into insignificance when compared to the carbon storage values.

Pearce (1996) looks at other potential estimates of global value. One approach is to see what the values for 'similar assets' would imply. Willingness to pay studies for the conservation of biological resources suggest average payments of perhaps \$10 p.a. per person. This would produce a fund of \$4 billion p.a. when applied to OECD households. This would translate to around \$2.3 per hectare if applied to all tropical forest. An alternative is to look at *implicit* prices in debt-for-nature swaps. How far the procedure of estimating implicit prices of this kind is open to doubt, although it has been used by some writers - see Ruitenbeek (1992) and Pearce and Moran (1994). The range of implicit values is from around 1 cent/ha to just over 4 dollars/ha (Pearce, 1996).

The estimates of non-use value are clearly very speculative and it is not even clear that the methodologies in question are eliciting non-use rather than some mixture of use and non-use values. As we have seen, the only direct approach based on contingent valuation suggests fairly significant values of \$13-27 ha for a small part of the total forest stock. The more indirect approaches suggest very much lower values of perhaps one tenth of the direct values.

## Annex 3 The economics of forest land use: the Hyde model

This annex outlines an analytical framework developed by Hyde et al (1996) and Hyde (1999), but includes a more explicit treatment of non-market values.

A distinction is made between three contexts: in the first the forest within the agricultural frontier is cleared and the residual, i.e. remaining forest, is not colonised. In the second case, forest values rise as people demand timber wood and fuelwood but no ‘forest sector’ emerges. In the third case forest values rise again, creating the conditions for a sustainable forest sector. These three contexts are depicted in Figures A3.1-A3.3. Other forest values – fruits, nuts, latex etc.- could be described in the same manner.

In each case, monetary values are measured on the vertical axis and distance from the initial site of origin is measured on the horizontal axis. NAV is the net agricultural value of the land; NFV is the net forest value of the land; MC is the marginal cost of securing rights to the land.

In Figure A3.1 NAV lies wholly outside the NFV curve so that crops are grown on 'secure' land up to the point D1 where MC just equals NAV. Pasture or grazing (and perhaps crops) take place on the area D1D2, but access is open and not subject to private rights. The residual standing forest exists from D2 to Dz. NFV lies wholly inside NAV so that the standing forest is degraded up to D2.

In Figure A3.2 NFV shifts outwards since there is a demand for wood (timber, fuelwood etc) and the new NFV curve cuts the NAV curve below the intersection of NAV with MC. Secure agriculture occurs up to D1, open access agriculture from D1 to D2 and the distance D2-D3 is degraded forest. It is degraded because the marginal cost of protection lies above the NFV curve. Note that in neither of the first two cases does a managed forest sector emerge.

In Figure A3.3 NFV shifts further to the right with the intersection of NFV and NAV lying above the intersection of NAV and MC. Up to D1 there is secure agriculture. Between D1 and D2 now there is a sustainable forest sector since forestry is the highest use value of that land and the MC of protection lies below the NFV curve. From D2 to D4 forest values dominate other uses, but the MC of protection is above the NFV curve. Hence D2D4 is degraded open access forest land, some of which may be used for agriculture.

The essence of the analysis is that it matters at what stage one is for policy purposes. In stages 1 and 2, a sustainable forest sector is not likely to develop. In stage 3 it is. As the NFV curve shifts outward, so the residual 'natural' forest is increasingly invaded, i.e. deforestation occurs. In cases 1 and 2 certain familiar forest policies will not work, e.g. giving away seedlings or some other form of subsidy. Measures to lower the marginal cost of protection can result in sustainable forestry (moving from case 2 to case 3) and might be typified by policies design to ensure community control of forests.

We can now introduce non-market values. The NFV curve in A2.1-3 are 'exploitative' curves, i.e. they involve forest uses that destroy the forest, with the exception of the sustainable forest section of NFV in Figure A3.3. Some non-market values can be realised only if the forest is protected and not used in an exploitative way. Carbon storage (as opposed to sequestration by growing trees) would be the obvious example and biodiversity might be another. Suppose that these values are large relative to other values, including timber values, as is suggested by Pearce (1998). For convenience suppose that they are also constant across all forest, which would be the case for carbon but is unlikely for bio-diversity. Then the NMFV curve in Figure A3.4 shows this value curve lying above other curves apart from a section of NAV. This suggests that secure agriculture would be practiced up to D1, whilst D1D2 would be sustainable forestry inclusive of carbon and biodiversity, and D2 onwards would be residual unprotected forest. The effect of the non-market values is therefore to greatly expand the sustainable forest sector, assuming, of course, that the non-market values are realised by, for example, international transfers such as carbon trades, GEF involvement, heritage financing etc.

**Figure A3.1**

**(A3.1)**

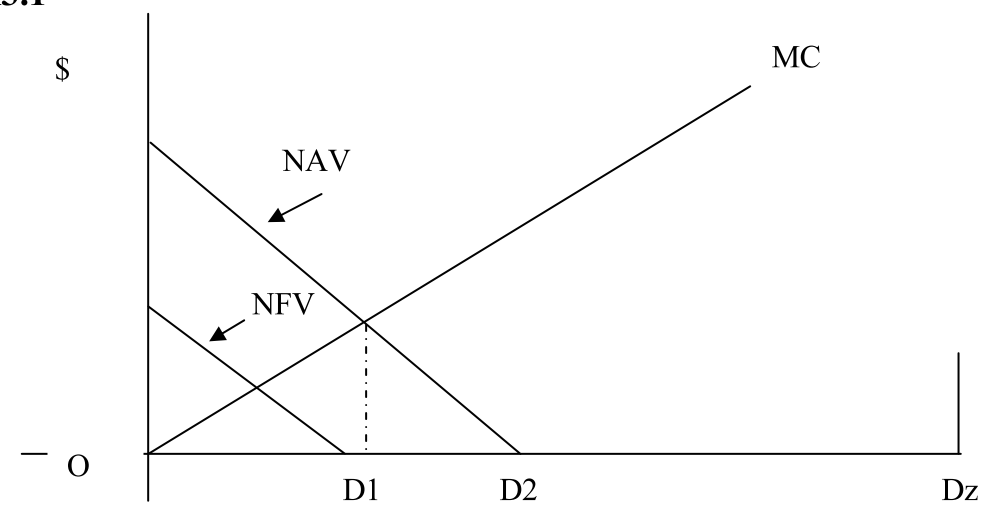


**Figure A3.2**

**(A3.2)**

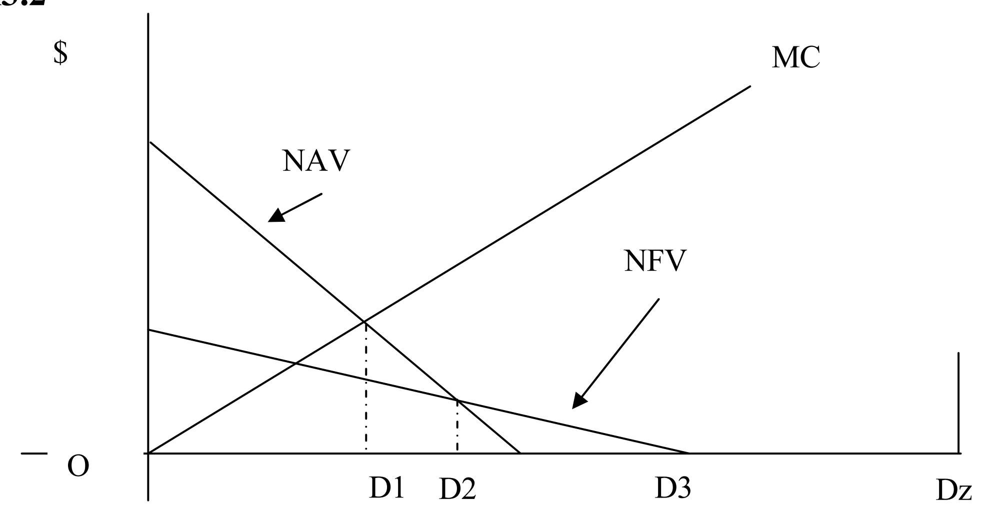

**Figure A3.3**

**(A3.3)**

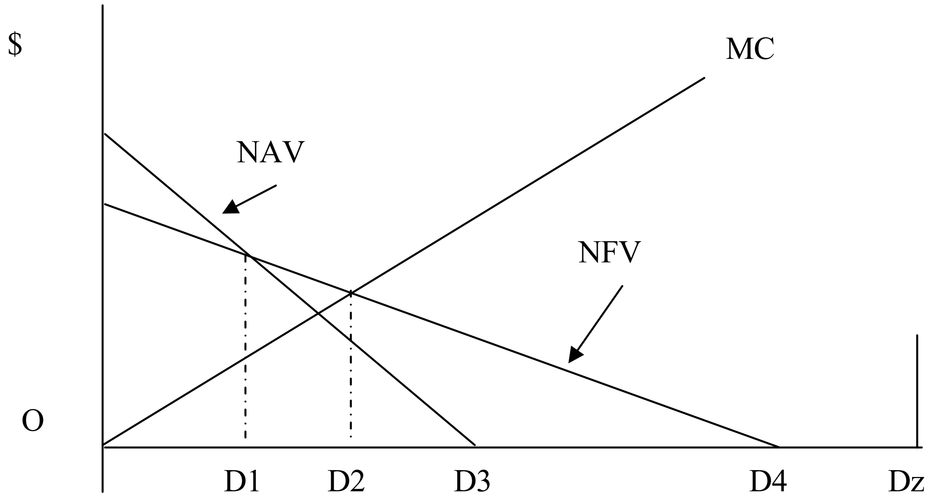


**Figure A3.4**

**(A3.4)**