The Cost of Avoiding Deforestation

Update of the Report prepared for the Stern Review of the Economics of Climate Change

Maryanne Grieg-Gran

May 2008

International Institute for Environment and Development

3, Endsleigh Street
London WC1H 0DD
Tel: 0207 388 2117
email: maryanne@iied.org

This paper was commissioned by the Office of Climate Change as background work to its report 'Climate Change: Financing Global Forests' (the Eliasch Review). Further information about the report is available from www.occ.gov.uk

1. Introduction

This report updates the estimates of opportunity costs produced for the Stern Review in October 2006 to take account of recent upward trends in commodity prices.

The objective of the original report was to support the work of the Stern Review on avoided deforestation by producing a global estimate of the cost of cutting the rate of deforestation in half within a decade. This work would include confirming or otherwise the costs of avoided deforestation per hectare by country available so far and providing further country numbers where possible.

The Terms of Reference set out three elements that payment to avoid deforestation at country level would need to cover:

1. Value of the economic activity per hectare that leads to deforestation i.e. usually agriculture – this will of course vary between countries reflecting different alternative land uses. For example, coffee, cattle farming, soya etc.

2. Administration, monitoring and enforcement costs for the government.

3. An incentive element to undertake this effectively.

Key countries highlighted in the Terms of Reference to included in this estimate were Brazil, Indonesia, Papua New Guinea, Cameroon, and Congo for the first element. This was because these countries all have large areas of tropical forest and are experiencing relatively high rates of deforestation. Countries like Costa Rica and China, which have taken action to address forest loss, were also identified in the TOR because of their potential importance for the second element of administration, monitoring and enforcement of reduced deforestation.

This report sets out the approach to calculation and results for the first two elements and provides details of the updates that have been made to the original estimates for opportunity cost. Some changes to the estimates of transactions costs for payments for environmental services schemes are also presented.

2. The Target

Deforestation is taken to mean here complete removal of forest vegetation to provide land for agricultural purposes or other land uses. Statistics on deforestation are not widely available and it is necessary to use the proxy of net forest loss which as it includes also afforestation, reforestation and natural expansion is likely to be an underestimate. FAO's Forest Resources Assessment 2005 gives a global deforestation estimate of 13 million ha per year on average for 2000-2005 based on the countries with net forest loss but recognizes that this is an underestimate. It does not give deforestation figures at a national level. This is because reporting countries do not break down change in forest area into its various components: afforestation, reforestation, natural expansion and deforestation. To cut the global rate of deforestation by half would therefore require a reduction in the annual area deforested of at least 6.5million ha. It is assumed that deforestation continues at the same global rate over the next ten years. Given the uncertainty over deforestation data and the trend to revise downwards previous net forest loss figures[1], this is not unreasonable.

3. The Approach

The terms of reference require the following countries to be included in the estimates of cost of foregone land use : Brazil, Indonesia, PNG, Cameroon and Congo. These countries all have large areas of tropical forest which are under threat from expanding agriculture and livestock sectors. Annual net forest loss in these countries equals 5.6 million ha, somewhat less than the target reduction required, even if deforestation were to be reduced 100% in all cases. Other countries where deforestation is considered serious and where data was readily available have been included. These are Ghana, Bolivia, and Malaysia. Annual net forest loss in these eight countries equals 6.2 million ha. Eliminating deforestation in all these countries would result in a 46% reduction in global deforestation[2].

This report makes a major simplifying assumption agreed with members of the Stern Review team. It is assumed that the governments of the countries concerned are able to implement a scheme at national level to avoid deforestation with 100% additionality and zero leakage. This means that it is only necessary to compensate for the area of annual deforestation as it is assumed that a national government is able to target this effectively.

It is also assumed that the alternative to deforestation is forest conservation without any exploitation of timber and corresponding revenues. This means that it is not necessary to factor in an offsetting stream of returns from sustainable forest management. Similarly, it is assumed that the benefits to landholders from conserving forests in terms of non-timber forest products are relatively minor or precluded by access and harvesting restrictions associated with a conservation regime.

Two main elements are needed for estimating the value of the economic activity that leads to deforestation:

- The return per hectare under different land uses and different conditions
- The size of the area to which the different cost estimates should be applied.

Estimation of returns to land

Three main approaches can be distinguished in the literature.

---

[1] FAO's Forest Resources Assessment (2005) presents estimates of annual global net forest loss for 1990-2000 that are 0.5 million ha less than the estimates for the same period in the 2000 Forest Resources Assessment.
[2] Note that this does not translate easily into a reduction of land use related greenhouse gas emissions as the estimates available for these, such as those produced by Houghton for WRI, use a broad definition of land use change which includes harvest of wood in addition to the FAO's four components of net change in forest area.

1) Estimates at the local/micro level

Some estimates have been made at the local level, often in small communities using a random sample household survey. While the results may be sound for that location and its particular circumstances, they are not necessarily capable of being extrapolated over a wider area on a reliable basis. As Chomitz (2006) and others have pointed out, the returns vary considerably according to the location. Opportunity costs depend on

- Type of land use for which the forest lands are appropriate
- Soil and climate conditions which in turn affect yields
- Scale of operation – small, medium, large
- Inputs and technology
- Distance from the market and quality of transport infrastructure.

Other factors complicating these estimates include:

- Differences in assumptions about the cost of labour, particularly family labour.
- Variation in prices of agricultural commodities over time – coffee prices for example between 1997 and 2001 fell by 70% in nominal terms and to below the costs of production in many producing countries (FAO 2005). More recently, palm oil prices doubled over the period 2005-2007.
- Differences in assumptions on discount rate and time horizon.

A key factor affecting the magnitude of the estimates is the treatment of the net costs of the conversion process to agriculture and pasture. There are revenues from one-off harvesting of commercially valuable timber but there are also costs of clearcutting the remaining trees and in the case of cattle ranching, of establishing the pasture. Merry et al (2001) in a study of Bolivia present data showing that the costs of clearing and pasture establishment exceed the revenues from the sale of timber or timber rights. They do not however, separate pasture establishment costs from clearing costs. Arima et al (2006) cite research for Brazil from the end of the 1980s that the sale of timber rights from 3 ha of forest was sufficient to finance the rehabilitation of one ha of pasture.

It is not always clear in the literature how this aspect has been dealt with and whether costs of clearing have been included in estimates of returns to agriculture or cattle ranching. Margulis (2003) includes in estimates of the returns to cattle ranching in Brazil the cost of clearing land and establishing pasture but excludes the returns from timber harvesting as it is assumed that the land has already been stripped of commercial timber. Other studies such as Arima and Uhl (1997) which gives estimates of returns to dairy farming in Brazil appear to exclude both clearing costs and pasture establishment. Vera Dias's (2005) estimate of annual returns per ha from soya production probably excludes clearing costs because it is assumed that production of this crop is preceded by several years of cattle ranching.

The returns to timber harvesting also vary considerably depending on location and proximity to market as well as density of commercial species. Barreto et al (1998) present data (taken from Stone 1996) showing how stumpage fees in Para, Brazil, vary by location, increasing with greater proximity to an urban centre. Within 20 km of the nearest town the stumpage fees were US$310 per ha, dropping to US$125 per ha at 130 km distance. The forest conversion process does not always involve timber harvesting or results in minimal returns to this activity because of legal, practical and market restrictions. For example, the country report for Cameroon of the Alternatives to Slash and Burn programme (Kotto-Same et al 2000) did not attempt to incorporate timber revenues in its estimates of returns to land use. This was because in Cameroon deforestation is primarily driven by smallholder agriculture. The State holds all timber rights and smallholders are prohibited from harvesting timber except for their own use. As a result timber is often burnt rather than sold. The ASB report for Indonesia (Tomich et al 1998) makes a similar argument for smallholder agriculture there.

2) Estimates based on generic/average data

There are also some generic estimates based on "average" production costs and revenues per hectare or per tonne of agricultural product or typical production costs. for the country. In some cases average costs or returns have been extrapolated from another country (eg Silva Chavez (2005) estimate of returns to soya production in Bolivia uses Brazil data). These estimates run the risk of not capturing local variation eg in yields or the differences between scales of operation. Some estimates eg Osafo (2005) on Ghana, do not include costs of production, equating opportunity cost to value of production. These overstate the opportunity costs of avoiding deforestation. To use such estimates it is necessary to make an assumption about the costs of production.

3) Land prices

In theory the price of land should reflect the discounted stream of returns from its most productive/valuable use. Land price estimates in the literature do not lend themselves well to indicating the cost of avoiding deforestation for two main reasons. Firstly, in large areas of forest in Brazil, for example, the problem of deforestation partly stems from the lack of clear ownership and lack of land markets. Settlers can obtain land for free and establish a claim to it by clearing the forest. In areas where land markets do exist, markets may not be well-developed with relatively few transactions so prices are not very representative. In addition, as Chomitz (2006) notes, in order for prices of land already converted and used as pasture to be indicative of the returns to converting forest land it would be necessary to deduct the net costs of clear-cutting timber after timber sales and the costs of planting the pasture. Studies reporting land prices in the literature rarely give this information (with the exception of Merry et al 2002) nor do they always make clear the essential characteristics of the land such tenure security, soil fertility, location which affect its price. Land prices may often reflect the returns from a potential land use rather than the actual land use (Arima et al 2006). For these reasons, the land price approach has not been used for this report even though some of the studies in the literature do report land prices.

Approach taken for this estimate

A combination of local-level estimates of returns and more generic estimates has been used for this report. The local level estimates tend to be for small-scale farmers and so are useful for this purpose. Adjustments made are as follows:

- All cost estimates are expressed in US$ and converted to 2007 prices using the GDP deflator except where 2007 data are used directly as part of updating.

- Annual returns per hectare are converted to net present value per hectare, with a 10% discount rate and a time horizon of 30 years. This is in line with some of the estimates in the literature. In some cases estimates already expressed in NPV terms in the literature were used. Most of these had been calculated with a 10% discount rate, the exceptions being the estimates for Indonesia made by the Alternatives to Slash and Burn programme (Tomich et al 1998) for which a rate of 20% was used and the estimates made by Zen et al (2005) for returns to oil palm in Indonesia which appear to be based on a 12% discount rate.

Some of the estimates in the original report have been further adjusted to take account of price trends or have been replaced by estimates based on new sources of information. The return to soybeans in Brazil is now derived from farm budgets prepared by the Ministry of Agriculture for 2007/08 and producer prices published by ABIOVE, the Brazilian Soya Producers Association. Full details of the updates are given in the Annex. Historic price data and forecasts of commodity prices where available were used to assess the need for adjusting the prices used in the original estimates and to determine whether the price level in 2007 is representative of the levels of the next 30 years. For palm oil, soya and beef it was possible to use forecasts of prices until 2017 produced by FAPRI (2008).

It is possible that commodity prices might also be affected by efforts to reduce deforestation as the effect would be to restrict growth in supply. Estimation of the likelihood and magnitude of such effects is beyond the scope of this report.

The land use returns per ha used to make the global and national level estimates are set out in Table 1 together with details of their source and rationale.

Three sets of cost estimates have been prepared, one assuming that no returns to one-off timber harvesting have to be compensated for as part of land conversion, another assuming that timber is harvested in 100% of the deforestation area and an intermediate scenario which takes account of practical limitations on timber harvesting in some of the countries concerned. The assumptions made for the intermediate scenario are as follows:

- Cameroon and DRC: no timber harvesting as deforestation is smallholder-driven

- Ghana: harvesting in 100% of the deforestation area

- Brazil: 70% - no timber harvesting in small-scale cattle ranching and food crops and in perennials areas.

- Bolivia: 30% - No timber harvesting in the cattle ranching area

- PNG: harvesting in 100% of the deforestation area (all forests community-owned)

- Indonesia: 66% - no timber harvesting in smallholder rice and manioc areas)

- Malaysia: 80% - no timber harvesting in rice fallow area

Determining the area to which cost estimates apply

Most of the cost estimates in the literature do not go beyond estimating a return per hectare to different land uses. To estimate the cost of avoiding deforestation at a national level it is necessary to apply these estimates to a geographical area. This means predicting how much of the area deforested each year will end up as different land uses, whether pasture, soybeans, food crops etc. In other words, how many hectares would be cleared for low return use and how many for high return crops such as soya? As land use patterns depend on a number of local factors such as soils, climate, access to markets, it is challenging to make robust predictions. Where estimates of returns differ according to scale it is also necessary to determine how much of the area deforested is likely to involve farms of different scales.

To make such predictions for Brazil, this report uses data from Chomitz and Thomas (2001) on proportions of cleared land in forest margin area that are dedicated to different types of land use. These authors show that 77% of cleared land in forest margins in Brazil is under pasture, 8% under annual crops. It might be reasonable therefore to assume that 77% of further land deforested in Brazil in the next few years will end up as pasture. Chomitz and Thomas (2001) also show that almost half of the agricultural land in these areas corresponds to large scale farms and only 1.5% to farms of less than 20 ha. Unfortunately, similar studies with such quantification of land use patterns do not appear to be available for the other significant deforestation countries.

The percentage breakdown of land uses in most cases is therefore based on more subjective assessment, drawing from qualitative statements in the literature about the importance of different land uses in deforested areas and land use patterns at national level. These assumptions are cross-checked where possible by recent trends in the number of hectares dedicated to different land uses. For example, for Indonesia, oil palm is considered to be a significant driver of deforestation. Between 1990 and 2003, the area dedicated to oil palm increased by roughly 12% per year (Zen *et al* 2005). Expansion in 2004 and 2005 has been at a similar rate. If it is assumed that all of this increase is associated with deforestation, then the current annual increase of oil palm area corresponds to 32% of the annual rate of deforestation. This provides some justification for assuming that 32% of the area deforested each year will be used for oilpalm. This of course assumes that past trends are a good guide to future trends. This may not be the case particularly when prices change.

In some cases though, there is very little information to draw from to justify the assumptions made. It is this aspect of the whole exercise that is the least robust.

The percentage breakdowns of land uses for each country that form the basis of the global and country level estimates are set out in Table 2. The rationale for making these assumptions is also given.

4. Results - Opportunity costs of foregone land uses

The updated estimates for opportunity costs of foregone land uses are set out by country in Table 3. These estimates show the land use returns that are forgone if deforestation is halted completely in the eight countries in one year and the area of forest that is conserved instead of cleared that year is maintained as forest over a thirty year period. Total costs for the eight countries are a little over US$4 billion. These costs increase to roughly US$ 8 billion if returns from one-off timber harvesting are included, as shown in Table 4. Costs in a more realistic scenario, which takes account of legal, practical and market constraints on timber harvesting, are roughly US$ 6.5 billion. These estimates are all roughly US$1.5 billion more than the corresponding estimates made in 2006, primarily because of the significant increase in the returns to oil palm.

Other factors that could affect the costs are the discount rate used to calculate NPV, the time horizon over which returns are calculated and the assumptions on commodity prices, whether a single year estimate at a low or a high point of the cycle or an average of several years. As oil palm constitutes a significant proportion of the opportunity costs, the results are sensitive to the assumptions made about price for this crop. For example, assuming that the price (and also the return per ha) of oil palm is 3 times that of 2005 levels, in line with prices for oil palm fruit in April 2008 – see Annex 1), the total costs under the medium timber harvesting scenario increase by roughly US$1 billion to US$7.5 billion.

A major influence on the results however, is the assumption about the proportion of deforested area that will be in high or low value agricultural alternative use. For example if it is assumed for each country that the highest return land use[3] in that country applies over the whole deforestation area, the total costs exceed US$23 billion, including returns from one-off timber harvesting. This increases to US$ 27.5 billion, if the higher price increase for oil palm is assumed.

These estimates are also highly dependent on the assumptions of 100% additionality and zero leakage. There are significant challenges in identifying and targeting areas most at risk from deforestation and preventing displacement of deforestation to other areas, as evidenced by experience with payments for environmental services schemes. For this reason, it is likely that activities to control deforestation such as compensation payments would have to be directed to an area larger than the desired reduction in deforestation at least in the initial years. This is illustrated by the experience of Mexico's Payments for Watershed services schemes. A model of deforestation risk was developed and a comparison was made with areas at risk and areas in the payment scheme (Muñoz et al 2005). The results showed that there was a lack of additionality. In 2003, only 11% of the participating hectares were classified as having high or very high deforestation risk. This increased however, to 28% in 2004.

[3] In the case of Brazil, the returns to soya were used for this estimate rather than the highest return land use (tree plantations) as this was considered to be a more likely threat at large scale.

5. Administration Costs[4]

Without full details of how a compensation scheme will operate at the country level and therefore which activities will be involved, estimates of administration costs can only be speculative. Chomitz (2006) argues that measurement, monitoring and transaction costs are prohibitively high at the property level, especially for small properties, raising doubts about the practicality of relying solely on payments to conserve forest at the individual forest owner level. He identifies a portfolio of interventions that governments can use to tackle deforestation such as fire prevention programmes, improvement of tenure security, enforcement of regulations against illegal deforestation, taxation of large scale land clearance, promotion of off-farm employment and intensification.

Whether a national government proceeds with a payments for environmental services approach or channels the money into improving enforcement of land use restrictions, there are some activities that will definitely be required such as monitoring of deforestation and measurement of forest carbon. Chomitz (2006) makes the point that there are economies of scale in sampling as the accuracy of the estimate depends on the size and representativeness of the sample, and not on the size of the population. Costs of monitoring deforestation at a rather coarse scale to pick up 25 ha patches would not differ so much by country and could be as little as US$2 million per year. This would not serve for an accurate assessment of changes in carbon stock but would be an important part of an implementation strategy (Chomitz pers comm.)

Experience from national level payment for environmental services schemes in Latin America gives some indication of the costs involved if a compensation scheme takes the form of payments. These have to be considered as lower bounds of the estimates as these schemes have been introduced in contexts where there were already institutions in place and a history of subsidies to forestry. FONAFIFO, the organisation that administers the Payments for Environment Services Scheme of Costa Rica is required by law to spend no more than 7% of its budget on administering the scheme and the rest on the payments. According to Rodriguez (2005), FONAFIFO's total budget over ten years has been 40 billion colones (US$110 million) giving an average annual administration budget of US$770,000. By October 2005, the programme had approximately 250,000 ha under contract (GEF 2005), implying an average administration cost of US$3 per hectare over the whole contracted area.

The payment scheme initiated in Mexico in 2003 also has a ceiling for costs of operation, evaluation and monitoring stipulated in the legislation, in this case 4% (Carlos Muñoz per comm). The annual budget for the scheme is US$18 million implying expenditure on administration of up to US$700,000 per year. This does not include fixed costs of computers, satellite access, land registry update etc which were paid for by the Forestry agency (Carlos Muñoz per comm.). Over the first three years of the programme some 480,000 ha were incorporated into the scheme, implying an

[4] This section draws on Grieg-Gran, M. (forthcoming 2008) The Cost of Avoided Deforestation as a Climate Change Mitigation Option in Palmer, C, and Engel, S. (Eds.)Avoided Deforestation. Prospects for Mitigating Climate Change. Routledge Explorations in Environmental Economics Series. 2008.

operational cost (excluding fixed costs) of US$1.5 per ha per year if the cumulative total is considered or US$4-6 per ha per year if new applications only are considered .

The national schemes in Costa Rica and Mexico have been introduced in contexts where there were already institutions in place and a history of subsidies to forestry, and so may underestimate administration costs in less favourable contexts. They are also not oriented specifically to GHG emission reductions but additionally or exclusively to other environmental services such as watershed protection. Monitoring has been mainly of changes in forest cover rather than delivery of carbon emission reductions. This information needs to be considered as a lower bound for administrative costs and to be supplemented by cost figures more representative of less favourable contexts where there is little existing institutional capacity.

Another issue is that PES recipients also incur costs in the application process and this will affect their decisions. The payment therefore needs to cover both the opportunity costs of the land use restriction as well as the transaction cost for applicants of entering the scheme. An indication of the magnitude of transaction costs assumed by applicants is given by the charges made by local intermediaries in Costa Rica to assist applicants with the process including technical assistance and monitoring. These range from 12% to 18% of the total amount of the contract over five years (Miranda *et al.*, 2003). Not all PES recipients need to make use of intermediaries. Assuming that 50% of PES recipients have to contract intermediaries to help them with their applications, including these costs in the calculation would almost double the administration costs bringing them to US$6 per ha at least for the first five years of a payment contract.[5] For renewal of the payment contract it is likely that administration costs for applicants would be lower.

To some extent the division of transaction costs between the administering agency and the applicants reflects the design of the scheme, as well as the strength of local institutions and the capacity of applicants. In contexts where there is less institutional capacity, it may be necessary for the administering agency to take on more of these costs. For this reason, we take the lower bound of administration costs to be US$4 per ha, per year (a third higher than the average annual cost in the Costa Rica scheme and double the average annual cost in Mexico to cover the transaction costs incurred by landowners.

At the other extreme, small local PES schemes have relatively high transaction costs reflecting the large fixed-cost element. For the scheme in Pimampiro, Ecuador, which has contracts with 19 landholders covering 550 ha forest and f native Andean grassland, the costs of monitoring and management are US$867 per year (Wunder and Alban 2008). To this needs to be added the costs of the start-up phase at US$38,000 (*ibid).* Spreading this cost over 30 years at an interest rate of 10% and adding to the annual monitoring and management costs gives an annual administration cost of US$9 per ha.

---

[5] If 50% of PES recipients pay 15% of their contracted amount to an intermediary, this implies an expenditure of roughly US$800,000 per year (50% of annual budget for payments net of administration costs = US$5.1 million times 15% = US$0.77 million). Including these costs in the calculation would almost double the administration costs

From these schemes, a lower bound figure for annual administration costs of US$4 per ha and an upper bound of US$9 per ha can be derived. These represent the likely range of operational costs of a compensation scheme employing a system of payments. This range includes the cost for the administering authority and the transaction costs likely to be incurred by landholders to apply to the scheme. These annual administration costs need to be discounted over 30 years in the same way as the opportunity costs. This is the amount of money that will be necessary to implement and maintain a payment scheme over the period required for avoided deforestation to constitute mitigation.

Annual administration costs per ha discounted over 30 years at 10% gives a range in net present value terms from US$38 to US$85 per ha with total costs for the eight countries ranging from US$233 million to US$0.5 billion, for the range of US$4 to 9 per ha per year as shown in Table 4. This is the cost of administering a payment scheme covering 6.2 million hectares over a 30 year period. For the medium timber scenario this increases total costs by between 3.5% and 8%.

Table 4 Costs of Administering a Payment Scheme

Country	**Costs for administering authority NPV US$ 000**	
	Lower	**Upper**
Cameroon	8,296	18,665
DRC	12,029	27,065
Ghana	4,336	9,757
Bolivia	10,181	22,907
Brazil	117,007	263,265
PNG	5,241	11,793
Indonesia	70,551	158,740
Malaysia	5,279	11,878
Total	**232,920**	**524,070**

Based on an annual lower bound of US$4 per ha and upper bound of US$9/ha
Source: Grieg-Gran (forthcoming) 2008

6. Conclusions

This report has estimated the avoided costs of deforestation for eight countries with large areas of tropical forest: Bolivia, Brazil, Cameroon, DRC, Ghana, Indonesia, Malaysia and PNG, updating the estimates to take account of recent commodity price trends. Annual net forest loss in these countries averaged 6.2 million ha over the period 2000-2005, equal to just under half of FAO's estimate of annual global deforestation in this period.

The total costs of avoided deforestation in the form of the net present value of returns from land uses that are prevented as a result of controlling deforestation for the eight countries concerned are a little over US$ 4 billion per year if no account is taken of the foregone returns to selective logging before forest clearing takes place. This would be representative of a situation where selective logging is allowed to proceed before conservation. Total costs increase to roughly US$ 8 billion per year if foregone returns from selective logging are included for all countries. Costs in a more realistic scenario which takes account of legal, practical and market restrictions on logging are somewhat less at US$6.5 billion per year.

These estimates are roughly US$ 1.5 billion higher than the corresponding estimates presented in the original report. The main reason for the difference is the significant increase in the price of palm oil since 2005. Costs associated with oil palm account for 45% of the total costs (excluding timber harvesting). For this reason, results are sensitive to the assumptions made about oil palm prices and costs of production. If it is assumed that oil palm prices and returns to land have tripled since 2005, in line with the most recent price information (April 2008), the total costs increase to US$7.5 billion in the medium timber harvesting scenario.

These estimates are heavily dependent on the assumptions made about returns to different types of agricultural activity and the patterns of land use in deforested areas. An upper bound to the estimates can be given by examining a scenario where the highest return land use in each country is assumed to occupy the whole of the annual deforested area. In this case, the costs increase to US$23 billion per year (including foregone returns from one-off timber harvesting.

The estimates are also highly dependent on the assumptions of 100% additionality and zero leakage. Costs would be higher if governments are not able to identify and target the areas most at risk from deforestation or are unable to prevent displacement of deforestation to other areas. This would mean that a larger area would need to be compensated to achieve the desired reduction in deforestation. There are also significant administration costs involved in achieving high additionality and low levels of leakage. This is a challenge that has faced payment for environmental services schemes.

Administrative costs for a scheme to control deforestation would be highly dependent on the nature of the measures taken. The existing payment for environmental services schemes in Central and South America provide some indication of annual operational costs if a system of compensating individual forest owners were adopted. From these schemes, a lower bound figure for annual administration costs of US$4 per ha and an upper bound of US$9 per ha can be derived. These represent the likely range of operational costs of a compensation scheme employing a system of payments.

Administration costs associated with payment schemes compensating for 6.2 million hectares of avoided deforestation would therefore range from US$233 million to US$0.5 billion, discounted over 30 years. For the medium timber scenario this increases total costs by between 3.5% and 8%.

Table 1 Derivation of Land Use Returns

Country	Land Uses	Returns *2007* US$/ha	Source/rationale
Cameroon	Annual food crops short fallow	821	Kotto-Same et al (2000) Table 16 page 35 Social returns to take account of trade restrictions
	Annual food crops long fallow	367	Kotto-Same et al (2000) Table 16 page 35 Social returns to take account of trade restrictions
	Cocoa with marketed fruit	1,448	Kotto-Same et al (2000) Table 16 page 35 Social returns to take account of trade restrictions
	Cocoa without marketed fruit	785	Kotto-Same et al (2000) Table 16 page 35 Social returns to take account of trade restrictions
	Oil palm and rubber	**2,360**	Doubling of estimate for social returns for rubber from Kotto-Same et al (2000) Table 16 page 35
	One-off timber harvesting	n.a.	Assume same as for Ghana
DRC	Annual food crops short fallow	821	Assume same as for Cameroon
	Annual food crops long fallow	367	Assume same as for Cameroon
	Cocoa with marketed fruit	1,448	Assume same as for Cameroon
	Cocoa without marketed fruit	785	Assume same as for Cameroon
	Oil palm and rubber	**2,360**	Assume same as for Cameroon
	One-off timber harvesting	n.a.	Assume same as for Cameroon
Ghana	Small-scale maize and cassava	209	Revenue per ha from Osafo 2005. Assume 15% return
	One-off timber harvesting	881	Osafo 2005 - Community's share of stumpage fees = US$498/ha. Total stumpage fees used.
Bolivia	Beef cattle	413	Assume Brazil figures apply
	Soya	**3,275**	Assume Brazil figures apply
	One-off timber harvesting	251	Assume same as for Brazil
Notes	*Returns are NPV in 2007 US$ at discount rate of 10% over 30 years except where otherwise stated*		

Table 1 Derivation of Land Use returns (continued)

Country	Land Uses	Returns 2007 US$/ha	Source/rationale
Brazil	Beef cattle medium/large scale	413	Margulis 2003 - Average of 5 representative farms in Para, Rondonia and Mato Grosso
	Beef cattle small scale	3	Lewis et al 2002 (ASB Brazil)
	Dairy	172	Arima and Uhl 1997 cited in Chomitz and Thomas 2001
	Soybeans	**3,275**	See Annex 1
	Manioc/rice	3	Assume same as for pasture Negative in ASB report
	Perennials bananas	3	Assume that perennials, fallow and degraded land have same return as manioc/rice
	Tree plantations	2,550	Assume same as for Coffee-bandarra system in Lewis et al 2002 (ASB Brazil)
	One-off timber harvesting	251	Average stumpage fee in Paragominas in 1995 Stone 1996 in Barreto et al 1998
PNG	Oilpalm estates	**3,340**	Assume same as for Indonesia - see Annex 1
	Smallholder oil palm	**960**	Assume same as for Indonesia - see Annex 1
	Smallholder subsistence crops	745	Gross returns from Anderson (2006) assume 10% return
	One-off timber harvesting	1,099	Tomich et al 2002 Assume that Indonesia estimates apply to PNG
Indonesia	Large scale oil palm	**3,340**	Doubling of estimate in Zen et al 2005, - see Annex 1
	Supported growers - oil palm	**2,100**	Doubling of estimate in Zen et al 2005, - see Annex 1
	High yield independent - oil palm	**2,340**	Doubling of estimate in Zen et al 2005, - see Annex 1
	Low yield independent - oil palm	**960**	Doubling of estimate in Zen et al 2005, - see Annex 1
	Smallholder rubber	**72**	Tomich et al 1998 (ASB Indonesia) Social prices 20% discount rate. Updated see Annex 1
	Rice fallow	28	Tomich et al 1998 (ASB Indonesia) Social prices (upper bound) 20% discount rate
	Cassava monoculture	19	Tomich et al 1998 (ASB Indonesia) Social prices 20% discount rate
	One-off timber harvesting	1,099	Tomich et al 2002
Malaysia	Oil palm Large scale/government	**3,340**	Assume same as for Indonesia - see Annex 1
	Oil palm supported growers	**2,100**	Assume same as for Indonesia - see Annex 1
	Oil palm Independent grower	**2,340**	Assume same as for high yield independent growers Indonesia - see Annex 1
	Smallholder rubber	**72**	Assume same as for Indonesia
	Rice fallow	28	Assume same as for Indonesia
	Cassava monoculture	19	Assume same as for Indonesia
	One-off timber harvesting	1099	Assume same as for Indonesia
Notes	*Returns are NPV in 2007 US$ at discount rate of 10% over 30 years except where otherwise stated Figures in bold have had major adjustments.*		

Table 2 Derivation of Land Uses

Country	Land Uses	% of Deforested Area	Rationale
Cameroon	Annual food crops short fallow	39%	Kotto-Same et al 2000 ASB Cameroon p6-7 and 52-53
	Annual food crops long fallow	20%	Kotto-Same et al 2000 ASB Cameroon p6-7 and 52-53
	Cocoa with marketed fruit	30%	Dominant land use but production not increasing because of low price
	Cocoa without marketed fruit	10%	Assume 25% of cocoa driven deforestation is in area too remote for sale of fruit
	Coffee	0.00%	Dominant land use but production area decreasing because of low price
	Oil palm and rubber	1%	Not considered a threat to deforestation by Kotto-Same et al 2000 ASB but increasing prices may change this. Oil palm area has increased by roughly 1000ha/yr since 2000
DRC	Annual food crops short fallow	39%	Same as for Cameroon
	Annual food crops long fallow	20%	Same as for Cameroon
	Cocoa with marketed fruit	30%	Same as for Cameroon
	Cocoa without marketed fruit	10%	Same as for Cameroon
	Coffee	0%	Same as for Cameroon
	Oil palm and rubber	1%	Same as for Cameroon
Ghana	Small-scale maize and cassava	100%	Osafo 2005
Bolivia	Beef cattle	70%	According to Merry 2002 important beyond peri-urban areas. Increase in cattle since 2001
	Soya	30%	Over 40% increase in area planted 1999 - 2004. Implies 70,000 ha/yr 26% of deforestation

Table 2 Continued

Country	Land Uses	% of Deforested Area	Rationale
Brazil	Beef cattle medium/large scale >200ha	63.0%	Chomitz and Thomas 2001: 77% of forest margin land was pasture. Table 2 p20 18.3% of agricultural land in farms of 20-200 ha = 14% of pasture. Assume that divided equally between beef cattle and dairy
	Beef cattle small scale (<200ha)	7.0%	
	Dairy	7.0%	
	Soybeans	5.0%	Chomitz and Thomas 2001: 8% of forest margin land was used for annual crops Assume that most but not all is for soybeans and rest for manioc/rice
	Manioc/rice	3.0%	
	Perennials bananas	1.0%	Chomitz and Thomas 2001: Less than 2% of agricultural land in perennials or planted forest
	Tree plantations	1.0%	
	Fallow	3%	Chomitz and Thomas 2001 - Assume return to manioc/rice applies
	Abandoned/degraded land	10%	
PNG	Oilpalm estates	33.30%	Oil palm fastest growing agricultural export so assume 50% of deforestation area
	Smallholder oil palm	16.65%	Split between estates and smallholders based on their share of production
	Smallholder subsistence crops	50.00%	Assumption based on importance of subsistence agriculture
Indonesia	Large scale oil palm	20%	12% annual average rate of expansion in area planted 1990-2003 and 2003-2005. 12% of area in 2005 =590 which equals 32% of annual deforestation area Vermeulen and Goad 2006 Assume percentages at national level apply in deforestation area
	Supported growers - oil palm	6%	
	High yield independent - oil palm	2%	
	Low yield independent - oil palm	4%	
	Smallholder rubber	30%	Assumption based on land use systems in Tomich et al 1998 (ASB Indonesia)
	Rice fallow	19%	Assumption based on land use systems in Tomich et al 1998 (ASB Indonesia)
	Cassava monoculture	19%	Assumption based on land use systems in Tomich et al 1998 (ASB Indonesia)
Malaysia	Oil palm Large scale/government	18%	Assume percentages at national level from Ismail et al 2003 apply in deforested areas
	Oil palm supported growers	9%	Assume percentages at national level from Ismail et al 2003 apply in deforested areas
	Oil palm Independent grower	3%	Assume percentages at national level from Ismail et al 2003 apply in deforested areas
	Smallholder rubber	30%	Based on Malaysian Rubber Board Statistics -Area increasing in Sabah and Sarawak since 1998
	Rice fallow	20%	Assumption based on land use systems in Tomich et al 1998 (ASB Indonesia)
	Cassava monoculture	20%	Assumption based on land use systems in Tomich et al 1998 (ASB Indonesia)

Table 3 Global and National Costs of Foregone Land Uses (excluding one-off timber harvesting) **2007 US$ 000**

Country	Land Uses	US/ha	No of ha (000)	Cost US$ 000
Cameroon	Annual food crops short fallow	821	85.8	70,447
	Annual food crops long fallow	367	44	16,156
	Cocoa with marketed fruit	1,448	66	95,589
	Cocoa without marketed fruit	785	22	17,278
	Oil palm and rubber	2,360	2.2	5,192
	Total		220	**204,662**
DRC	Annual food crops short fallow	821	124.41	102,148
	Annual food crops long fallow	367	63.8	23,426
	Cocoa with marketed fruit	1,448	95.7	138,605
	Cocoa without marketed fruit	785	31.9	25,053
	Oil palm and rubber	2,360	3.19	7,528
	Total		319	**296,760**
Ghana	Small-scale maize and cassava	209	115	24,058
	Total		115	**24,058**
Bolivia	Beef cattle	413	189	77,988
	Soya	3,275	81	265,262
	Total		270	**343,250**
Brazil	Beef cattle medium/large scale	413	1,955	806,657
	Beef cattle small scale	3	217	567
	Dairy	172	217	37,344
	Soybeans	3,275	155	508,091
	Manioc/rice	3	496	1,295
	Perennials (Bananas, sugarcane pineapplesNPV	3	31	81
	Tree plantations	2,550	31	79,125
	Total		3,103	**1,433,159**
PNG	Oilpalm estates	3,340	46	154,753
	Smallholder oil palm	960	23	22,240
	Smallholder subsistence crops	745	70	51,771
	Total		139	**228,764**
Indonesia	Large scale oil palm	3,340	380	1,268,297
	Supported growers - oil palm	2,100	109	229,556
	High yield independent - oil palm	2,340	30	71,291
	Low yield independent - oil palm	960	79	76,043
	Smallholder rubber	72	561	40,414
	Rice fallow	28	355	9,846
	Cassava monoculture	19	355	6,873
	Total		1,871	**1,702,319**
Malaysia	Oil palm Large scale/government	3,340	25	84,646
	Oil palm supported growers	2,100	13	26,681
	Oil palm Independent grower	2,340	4	9,246
	Smallholder rubber	72	42	3,024
	Rice fallow	28	28	775
	Cassava monoculture	19	28	541
	Total		140	**124,915**
	GRAND TOTAL		**6,177**	**4,357,887**

Table 4 Global and National Costs of Foregone Land Uses (including one-off timber harvesting) 2007 US$ 000

Country	Land Uses	US/ha	No of ha (000)	Cost US$ 000
Cameroon	Annual food crops short fallow	1,702	86	146,032
	Annual food crops long fallow	1,248	44	54,917
	Cocoa with marketed fruit	2,329	66	153,732
	Cocoa without marketed fruit	1,666	22	36,659
	Oil palm and rubber	3,241	2	7,130
	Total		220	**398,470**
DRC	Annual food crops short fallow	1,702	124	211,746
	Annual food crops long fallow	1,248	64	79,630
	Cocoa with marketed fruit	2,329	96	222,911
	Cocoa without marketed fruit	1,666	32	53,155
	Oil palm and rubber	3,241	3	10,339
	Total		319	577,781
Ghana	Small-scale maize and cassava	1,090	115	125,366
	Total		115	**125,366**
Bolivia	Beef cattle	663	189	125,379
	Soya	3,526	81	285,572
	Total		270	**410,951**
Brazil	Beef cattle medium/large scale	663	1,955	1,296,837
	Beef cattle small scale	253	217	55,031
	Dairy	423	217	91,808
	Soybeans	3,526	155	546,994
	Manioc/rice	253	496	125,785
	Perennials (Bananas, sugarcane pineapplesNPV	253	31	7,862
	Tree plantations	2,801	31	86,906
	Total	0	3,103	**2,211,222**
PNG	Oilpalm estates	4,439	46	205,657
	Smallholder oil palm	2,059	23	47,692
	Smallholder subsistence crops	1,844	70	128,125
	Total		139	**381,473**
Indonesia	Large scale oil palm	4,439	380	1,685,479
	Supported growers	3,199	109	349,650
	High yield independent	3,439	30	104,762
	Low yield independent	2,059	79	163,068
	Smallholder rubber	1,171	561	657,074
	Rice fallow	1,126	355	400,397
	Cassava monoculture	1,118	355	397,425
	Total		1,871	**3,757,854**
Malaysia	Oil palm Large scale/government	4,439	25	112,489
	Oil palm supported growers	3,199	13	40,640
	Oil palm Independent grower	3,439	4	13,587
	Smallholder rubber	1,171	42	49,166
	Rice fallow	1,126	28	31,537
	Cassava monoculture	1,118	28	31,303
	Total		140	**278,723**
	GRAND TOTAL		**6,177**	**8,141,840**

Table 5 Global and National Costs of Foregone Land Uses (medium scenario of one-off timber harvesting) 2007 US$ 000

Country	Land Uses	US/ha	No of ha (000)	Cost US$ 000
Cameroon	Annual food crops short fallow	821	86	70,447
	Annual food crops long fallow	367	44	16,156
	Cocoa with marketed fruit	1,448	66	95,589
	Cocoa without marketed fruit	785	22	17,278
	Oil palm and rubber	2,360	2	5,192
	Total		220	204,662
DRC	Annual food crops short fallow	821	124	102,148
	Annual food crops long fallow	367	64	23,426
	Cocoa with marketed fruit	1,448	96	138,605
	Cocoa without marketed fruit	785	32	25,053
	Oil palm and rubber	2,360	3	7,528
	Total		319	296,760
Ghana	Small-scale maize and cassava	1,090	115	125,366
	Total		115	**125,366**
Bolivia	Beef cattle	413	189	77,988
	Soya	3,526	81	285,572
	Total		270	**363,560**
Brazil	Beef cattle medium/large scale	663	1,955	1,296,837
	Beef cattle small scale	3	217	567
	Dairy	172	217	37,344
	Soybeans	3,526	155	546,994
	Manioc/rice	3	496	1,295
	Perennials (Bananas, sugarcane pineapplesNPV	253	31	7,862
	Tree plantations	2,801	31	86,906
	Total	0	3,103	**1,977,803**
PNG	Oilpalm estates	4,439	46	205,657
	Smallholder oil palm	2,059	23	47,692
	Smallholder subsistence crops	1,844	70	128,125
	Total		139	**381,473**
Indonesia	Large scale oil palm	4,439	380	1,685,479
	Supported growers	3,199	109	349,650
	High yield independent	3,439	30	104,762
	Low yield independent	2,059	79	163,068
	Smallholder rubber	1,171	561	657,074
	Rice fallow	28	355	9,846
	Cassava monoculture	19	355	6,873
	Total		1,871	**2,976,751**
Malaysia	Oil palm Large scale/government	4,439	25	112,489
	Oil palm supported growers	3,199	13	40,640
	Oil palm Independent grower	3,439	4	13,587
	Smallholder rubber	1,171	42	49,166
	Rice fallow	28	28	775
	Cassava monoculture	1,118	28	31,303
	Total		140	**247,961**
	GRAND TOTAL		**6,177**	**6,574,337**

References

Anderson T. (2006) Oil Palm and small farmers in Papua New Guinea. Report for the Centre for Environmental Law and Community Rights on the economic prospects for small farmers in PNG's oil palm industry. May 2006

Arima, E. and C. Uhl (1996) Pecuária na Amazônia Oriental: Desempenho Atual e Perspectivas Futuras, Série Amazônia No.1, Belém, IMAZON

Arima, E. Barreto, P. and M. Brito(2005) Pecuária na Amazônia: Tendência e Implicaçoes para a conservaçao ambiental Belém,. IMAZON

Barreto, P., Amaral, Pl, Vidal, El and C. Uhl (1998) Custos e Benefícios do Manejo Florestal para Produçao de Madeira na Amazônia Oriental. Série Amazônia No 10. Belém: Imazon.

Chomitz, K.M. and Thomas, T. S. (2001) Geographic Patterns of Land Use and Land Intensity in the Brazilian Amazon. Development Research Group, World Bank with contributions by IBGE, University of Washington CAMREX Project, and IMAZON.

Chomitz, K. M (2006) At Loggerheads? Agricultural Expansion, Poverty Reduction and Environment in the Tropical Forests. A World Bank Policy Research Report Review Draft .

DTE 2005. Indigenous peoples oppose oil palm in West Kalimantan. Down to Earth (Indonesia) Newsletter 66: 2-4.

DTE 2006. Communities challenge palm oil industry promise of sustainability. Down to Earth (Indonesia) Newsletter 68: 1-3.

FAO (2005) Global Forest Resources Assessment Progress towards sustainable forest management.

FAO database: http://faostat.fao.org/ FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

GEF (2005) Project Executive Summary GEF Council Submission http://www.gefweb.org/Documents/Work_Programs/documents/Costa_Rica_Mainstreaming_Instruments_ExecSumm.pdf

Grieg-Gran, M. (forthcoming 2008) The Costs of Avoided Deforestation as a Climate Change Mitigation Option in Palmer, C. and Engel, S. (Eds.) Avoided Deforestation Prospects for Mitigating Climate Change. Routledge Explorations in Environmental Economics Series.

Ismail A., Simeh, M.A. and M. Mohd Noor (2003) The Production Cost of Oil Palm Fresh Fruit Bunches: the Case of Independent Smallholders in Johor, Malaysian Palm oil Board.

Kotto-Same, J et al 2000 Summary Report and Synthesis of Phase II in Cameroon. Alternatives to Slash and Burn ICRAF, Nairobi.

Lewis, J., Vosti, S., Witcover, J., Erickson, P.J., Guevara, R. and T. Tomich (2002) Alternatives to Slash and Burn in Brazil Summary Report and Synthesis of Phase II. Alternatives to Slash and Burn, ICRAF, Nairobi.

Margulis, S. 2003. "Causas do desmatamento de Amazônia brasileira." 100. World Bank: Brasília.

http://www.obancomundial.org/index.php/content/view_document/1667.html

Merry,F. D., P. E. Hildebrand, P. Pattie and D. R. Carter (2002) An analysis of land conversion from sustainable forestry to pasture: a case study in the Bolivian Lowlands. *Land Use Policy* 19. (3): 207-215

Miranda, M., Porras, I.T., and M.L. Moreno (2003) The social impacts of payments for environmental services in Costa Rica. A quantitative field survey and analysis of the Virilla watershed. International Institute for Environment and Development, London.

Moutinho, P and Schwartzman, S. (2005) Tropical Deforestation and Climate Change. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005 http://www.environmentaldefense.org/documents/4930_TropicalDeforestation_and_ClimateChange.pdf

Munôz-Piña, C, Guevara, A., Torres, J.M, and J. Braña (2005) Paying for the Hydrological Services of Mexico's Forests: analysis, negotiations and results. Instituto Nacional de Ecología, Mexico.

Osafo, Y.B. Reducing Emissions from Tropical Deforestation: applying compensated reduction in Ghana in Moutinho, P and Schwartzman, S. (2005*) Tropical Deforestation and Climate Change*. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005

Rodriguez, J.M. ed. (2005) The Environmental Services Program: A success story of sustainable development implementation in Costa Rica. FONAFIFO, over a decade of action. Costa Rica National Forestry Fund (FONAFIFO) San José.

Silva-Chávez (2005) Reducing greenhouse gas emissions from tropical deforestation by applying compensated reduction to Bolivia, Environmental Defense, USA. in Moutinho, P and Schwartzman, S. (2005*) Tropical Deforestation and Climate Change*. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005

Tomich, T,P, van Noordwijk, M., Budidarsono, S., Gillison, A, Kusumanto, T. and D. Murdiyarso (1998) Alternatives to Flash and Burn in Indonesia. Summary Report and synthesis of Phase II. ASB, ICRAF, Nairobi

Tomich, T.P, De Foresta, H., Dennis, R., Ketterings, Q., Murdiyarso, D., Palm, C., Stolle, F., Suyanto and van Noordwijk, M. (2002) "Carbon offsets for conservation and development in Indonesia?" *American Journal of Alternative Agriculture.* 17. (3): 38-50

Tomich, T. P., Cattaneo, A., Chater, S., Geist, H.J., Gockowski, J., Kaimowitz, D., Lambin, E.F., Lewis, J, Ndoye, O., Palm, C., Stolle, F., Sunderlin, W., Valentim, J.F., van Noordwijk, M. and Vosti, S.A. (2005) "Balancing agricultural development and environmental objectives: Assessing tradeoffs in the humid tropics". In Palm, C.A, Vosti, S.A., Sanchez, P.A., Ericksen, P.J. and Juo, A.S.R. , eds*. Slash and Burn: The search for alternatives* Columbia University Press, New York, USA http://www.worldagroforestry.org/sea/Publications/searchpub.asp?publishid=1311

Vera Diaz M, C. and S. Schwartzman (2005) Carbon offsets and land use in the Brazilian Amazon in in Moutinho, P and Schwartzman, S. (2005*) Tropical Deforestation and Climate Change*. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005

Vermeulen, S., and N. Goad (2006) Towards better practice in smallholder palm oil production. IIED

Wunder, S. and M. Albán, (2008). Decentralized payment for Environmental Services: The cases of Pimampiro and PROFAFOR in Ecuador. Ecological Economics Volume 65, Issue 4, May 2008 p685-698

Zen, Z., Barlow, C. and Gondowarsito, R. 2005. Oil palm in Indonesian socio-economic improvement: a review of options. Working Paper in Trade and Economics 11. Economics, Research School of Pacific and Asian Studies, Australian National University.

Annex 1
Adjustments made to estimated returns for each land use

Oil Palm (Indonesia, Malaysia, PNG, Cameroon and DRC)
Over the last two years prices for palm oil have increased considerably and are likely to remain high in the future. The Rotterdam CIF price for palm oil in 2007/08 was US$ 1046, more than double the price in 2005/06. This is because of a number of factors including biofuels demand, high crude oil prices and increasing demand for edible oils in emerging markets. The Food and Agriculture Research Policy Institute in the US (FAPRI 2008) expects palm oil consumption to increase by 46 per cent over the next ten years and forecasts that palm oil prices in nominal terms will remain above US$1000 per tonne over the next 10 years, rising to US$1,338 by 2017/18. Prices in real terms, assuming an inflation rate of 2.5% per annum, would remain around US$1000 per tonne over the ten year period. The returns per hectare for oil palm are therefore likely to be considerably higher than the estimates given in the 2006 report.

To make the updates it is necessary to work with the price of fresh fruit bunches (FFB) as this is what the original estimates are based on. It is the price that smallholders and estates receive for FFB that affects the returns to land from converting forest to oil palm. FFB prices are not systematically recorded but some scattered information is available from newspaper articles and company reports which indicate significant price increases from those reported in Zen et al 2005 for Indonesia (441-600 IDR/kg US$45-62 per tonne) and Ismail et al 2003 for Malaysia (RM 188 per tonne) as well as price increases continuing in 2007 and 2008.

Indonesia

An Indonesian company, Ciliandra Perkasa[6] reports average FFB prices for the first half of 2007 of IDR 1.04 million (US$ 114) per tonne up from IDR 0.72 million in the first half of 2006. Zen et al 2005 reported prices ranging between 441 to 600 IDR/kg depending on type of producer in the period 2002 to 2005. This implies that the price in early 2007 had increased by 74% to 136% over the prices reported by Zen et al.

Malaysia

The available data shows a steady increase in FFB prices over the course of 2007 and increasing still further in 2008.

- Multi Vest Resources Berhad in its 2007 annual report (for year ending 30/06/07) indicates an average selling price for FFB in 2007 of RM356 (US$102, IDR 0.9 million), up from RM276 in the previous year.

- Sime Darby Berhad in its 2007 annual report (for year ending 30/06/07) indicates an average selling price for FFB in 2007 of RM 375 (US$108, IDR 0.96 million) up from RM293 in the previous year.

[6]http://www.ciliandraperkasa.co.id/assets/files/1H%20FY07%20Financial%20Results%20Announcement.pdf

- KL Kepong Berhad[7] in its 2007 (for year ending 30/09/07) annual report indicates an average selling price for FFB in 2007 of RM 465, (US$134, IDR 1.2 million) up from RM 285 in 2006.

- In early January, 2008 the FFB price in Malaysia was reported in the national press to be RM 600 per tonne[8] (US$174 and IDR 1.59 million).

- The Star, April 11, 2008 refers to FFB prices in Malaysia of RM 700 per tonne[9] (US$203)

The price reported by KL Kepong Berhad for the first nine months of 2007, US$134 is a little over double the price for FFB from estates in Zen et al 2005. But the price at the beginning of 2008 is 2.8 times the 2005 price. The most recent price recorded (in April 2008) is over three times the price in Zen et al 2005.

The price in 2007 is considered an appropriate reference point for updating the estimates. Although there have been further significant increases in price in 2008 it is not clear that they will be sustained over the long term. Use of the 2007 price level for FFB is consistent with the FAPRI forecasts for the Rotterdam CIF palm oil price which indicate that in real terms prices will remain at the 2007 level over the next ten years.

It is also necessary to take account of changes in the cost of production as fertilizers, pesticides and diesel represent a large share of production and have been affected by increasing crude oil prices. According to Papenfus (2000), fertilizers, herbicides and pesticides constitute over 60% of the costs of establishment of smallholder oil palm. These inputs are also important components of operating costs. In the absence of data on current costs of production of FFB, it is assumed that they have increased at the same rate as prices. This is probably an overestimate of production costs as labour costs are not likely to have increased at this rate.

If prices have doubled and costs have increased significantly but not necessarily at the same high rate as prices, then it is reasonable to assume that the returns to land will at a minimum have doubled also. For the main estimate therefore, the returns per hectare for oil palm in the 2006 report are doubled. This adjustment is made for all the five countries with this crop included in the 2006 report[10]. For sensitivity analysis, a tripling of the price to the level recorded most recently and hence tripling of the return per ha is examined.

Soybeans (Brazil and Bolivia)

The price of soybeans has risen significantly over the last two years. According to FAPRI (2008) the Rotterdam CIF price was US$496 per tonne in 2007/08 compared with US$261 in 2005/06. FAPRI forecasts for the next 10 years indicate that prices

---

[7] http://www.klk.com.my/busi_plantation_ps.htm

[8] http://www.btimes.com.my/Current_News/BTIMES/Industries/Commodities/GOODTI.xml/Article/

[9] WWW.palmoilprices.net/news/cbip-sees-better-plantation-earnings-in-fy08

[10] In this update, estimates for oil palm returns in Malaysia are all based on the estimates for Indonesia in Zen et al 2005.

will increase further in 2008/09 to US$506 and then fall slightly staying in the range US$470 - 492 in nominal terms for the rest of the period, implying a small decline in real terms.

While soybean prices in 2008 have been rising further, the FAPRI forecasts suggest that prices in 2007 can be considered a reasonable indication of future prices. For the adjustment, the average monthly producer price[11] for the second half for 2007 for Rondonopolis, Mato Grosso, was used. This equates to US$373 per tonne, somewhat lower than the price for January 2008 (US$452).

Costs of production will have been affected by increasing fertilizer and diesel prices. Ex ante estimates of production costs per hectare are made each year by EMBRAPA, the research organization of the Brazilian Ministry of Agriculture for different locations and production system. Production costs for four municipalities in the state of Mato Grosso (Richietti 2007) were averaged. Returns per ha in the second half of 2007 came to US$358, significantly more than the estimate of US$ 212 (Vera Diaz and Schwartzman 2005) that was used in the October 2006 report.

Rubber (Indonesia and Malaysia)
The original estimates were based on prices in 1997. Price trend data from the Association of Natural Rubber Producing Countries (ANRPC 2006) show that prices in 2006 were more than double the 1997 price level. These high prices have been maintained throughout 2007[12]. No long-term price forecasts have been identified for this commodity but there is little indication that the price will drop back to 1997 levels. Prices of natural rubber tend to follow those of oil so are likely to remain close to their current levels. In the absence of readily available information on local prices and costs of production, an assumption was made that the returns per hectare to smallholders would double. The contribution of natural rubber to the estimates in the 2006 report was very low so this adjustment makes very little difference to the overall total.

Beef (Brazil and Bolivia)
FAPRI historic price data and projections for Brazil show that future nominal prices in R/tonne over next 10 years will on average be lower than the prices prevailing in 2006 and 2002, the year to which the land use return estimates for medium and large scale beef cattle refer. Therefore no adjustments were made for large and medium scale beef and dairy. This is consistent with projections of world prices in OECD-FAO Agricultural Outlook 2007-2016, which indicate that high prices in 2006 in EU and US will not be sustained over the following 10 years.

Cocoa (Cameroon and DRC)
The original estimates were based on 1996 prices, which were around US$1,500 per tonne. FAO (2006) shows that prices in 2004-2006 were at similar levels in nominal terms. They have since increased to US$2,500 per tonne but are not expected to stay at this level. ICCO expects prices to decline in 2008/09 because of an increase in the stocks-to-grindings ratio but to increase again in 2009. Prices in constant terms in 2011 are forecast to be about 14% higher in real terms than prices in 2005 (ICCO

[11] www.abiove.com.br
[12] www.rubberstudy.com/statistics-quarstat.aspx

2007). As this forecast increase is not large, no further adjustment was made beyond converting to 2007 US$.

Maize and Cassava (Ghana)
Increases in food prices, including cereals and staple food crops, have been widely reported (FAO 2008). In West Africa, for locally grown crops these increases reflect factors of a temporary nature such as drought although the situation has been exacerbated this year by the increase in world commodity prices (FAO 2008). As these are mainly local crops grown for subsistence, it is assumed that production is not responsive to world trends. For this reason, no further adjustment was made beyond converting to 2007 US$.

Timber (All countries)
Prices of tropical timber, including logs increased in most regions in 2005 and 2006 but have started to level off in 2008. ITTO's March 2008 market review suggests that already there are signs of market cooling. For this reason, it is not expected that prices will increase further. The implications of this price increase vary by region depending on previous price trends.

Southeast Asia - In real terms (and for some species in nominal terms also eg kapur, keruing and meranti) prices of Malaysian logs in early 2007 were still not as high as levels reached in the early 1990s (ITTO 2006). The figure for stumpage fees in Indonesia (Tomich et al 2002) used in the original estimates was based on an average of 10 years (1987-1997) and therefore captured the high prices prevailing before the Asian financial crisis. . As current prices are still on a par with the early 1990 prices, no adjustments have been made to the stumpage fees estimate used for Indonesia, Malaysia and Papua New Guinea in the October 2006 report.

West Africa - The estimate for Ghana has not been adjusted for similar reasons. The original estimate (Osafo 2005) appears to be based on 2005 prices and although there have been rises since then, they have not been so marked as in other regions. In 2008, it appears that the market is slowing down. ITTO (March 2008) states that this has been the worst year for West African hardwood supplies.

South America - Price trends for Brazilian Jatoba sawnwood in ITTO (2006) show that prices were relatively low in the mid 1990s. As the original estimate was based on average stumpage fees (US$193/ha) in Paragominas, in 1995 (Barreto et al 1998 citing Stone 1996), this suggests that some upward adjustment is needed. However, a more recent estimate of stumpage fees based on a sample of sawmills in five Amazon states of Brazil, is lower. Bauch et al (2007) found an average stumpage fee of US$180 per ha in 2003, when sawnwood prices in both nominal and real terms were higher than in 1995. In the absence of more recent estimates of stumpage fees, no further adjustment has been made, other than converting to 2007 US$..

References

ANRPC (2006) Quarterly Natural Rubber Statistical Bulletin Volume 31, Number 1April 2006. Secretariat of the Association of Natural Rubber Producing Countries, Kuala Lumpur, Malaysia.

Barreto, P., Amaral, Pl, Vidal, El and C. Uhl (1998) Custos e Benefícios do Manejo Florestal para Produçao de Madeira na Amazônia Oriental. Série Amazônia No 10. Belém: Imazon.

Bauch, S.C., Amacher, G.S., and F.D. Merry (2007) Costs of harvesting, transportation and milling in the Brazilian Amazon: Estimation and policy implications. *Forest Policy and Economics* 9 p903-915

FAO (2006) The State of Agricultural Commodity Markets. Food and Agriculture Organization of the United Nations, Rome

FAO (2008) Crop Prospects and Food Situation No. 1 February 2008 GIEWS Global information and early warning system on food and agriculture, Food and Agriculture Organization, Rome.

FAPRI (2008) World Agricultural Outlook. Food and Agriculture Research Policy Institute Center for Agricultural and Rural Development, Iowa State University, Ames,Iowa.

ICCO (2007) Annual Forecasts of Production and Consumption and Estimates of Production Levels to Achieve Equilibrium in the World Cocoa Market, Market Committee Eleventh Meeting, 5 July 2007, London.

ITTO (2006) Annual Review and Assessment of the World Timber Situation 2006. International Tropical Timber Organization

ITTO (2008) Tropical Timber Market Report 13:6 16-31 March

OECD- FAO (2007) Agricultural Outlook 2007-2016 Organisation for Economic Cooperation and Development, Food and Agriculture Organization of the United Nations.

Osafo, Y.B. Reducing Emissions from Tropical Deforestation: applying compensated reduction in Ghana in Moutinho, P and Schwartzman, S. (2005*) Tropical Deforestation and Climate Change*. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005

Papenfus, M.M. (2000) Investing in Oil Palm: An Analysis of Independent Smallholder Oil Palm Adoption in Sumatra, Indonesia. Southeast Asia Policy Research Working Paper, No. 15. ICRAF Southeast Asia., Bogor.

Richietti, A. Estimativa do Custo de Produção de Soja, Safra 2007/08, para Mato Grosso do Sul e Mato Grosso. Comunicado Técnico 134, EMBRAPA, Dourados, MS. October 2007

Tomich, T.P, De Foresta, H., Dennis, R., Ketterings, Q., Murdiyarso, D., Palm, C., Stolle, F., Suyanto and van Noordwijk, M. (2002) "Carbon offsets for conservation and development in Indonesia?" *American Journal of Alternative Agriculture.* 17. (3): 38-50

Vera Diaz M, C. and S. Schwartzman (2005) Carbon offsets and land use in the Brazilian Amazon in in Moutinho, P and Schwartzman, S. (2005*) Tropical Deforestation and Climate Change*. Amazon Institute for Environmental Research. Belém – Pará and Washington DC - USA Environmental Defense, 2005

Zen, Z., Barlow, C. and Gondowarsito, R. 2005. Oil palm in Indonesian socio-economic improvement: a review of options. Working Paper in Trade and Economics 11. Economics, Research School of Pacific and Asian Studies, Australian National University.