Literature review:
Methodologies for financial and economic assessment of forest ecosystem services and land uses that cause deforestation in Borneo

Heart of Borneo Network Initiative

WWF

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EXECUTIVE SUMMARY

1. The objectives of the literature review are: 1) to summarize information and methodologies for the financial and economic analysis of logging, palm oil, timber plantation and coal mining in Borneo; 2) to summarize methodologies to value forest ecosystem services and compare them with extractive sectors; and 3) to identify and summarize the research that has been done in Borneo related to these topics.

2. Of the 24 studies reviewed, ten were carried out in Borneo (eight in Kalimantan, two in Sabah or Sarawak and one in the Heart of Borneo across Malaysia, Brunei and Indonesia). Four other studies were from other parts of Indonesia and one from Peninsular Malaysia. There were also four studies referring to the entire Indonesia, four to other parts or the world and one global study. All studies were dated from 2000 to 2010.

3. The main topics addressed by the literature were: i) financial analysis of oil palm vs. carbon credits for REDD; ii) financial analysis of conventional logging vs. reduced impact logging; iii) cost-benefit analysis for timber plantation companies; iv) cost-benefit analysis for biodiversity conservation; v) estimation of lost revenue from illegal logging; vi) impact of coal mining on the economy; vii) rapid economic valuation of ecosystem services for input on policy decisions; and viii) total economic valuation of forests under deforestation or conservation scenarios.

4. To carry out financial analyses of palm oil plantations, the studies calculated its Net Present Value (NPV) by looking at production output and plantation costs throughout the productive lifetime of an oil palm (20-30 years). Various studies incorporated the financial benefits obtained from logging during forest clearing and also undertook sensitivity analysis of the NPV with multiple variables, including discount rates, palm oil market prices and different plantation scenarios.

5. There were no studies presenting a full economic analysis of palm oil plantations, although some addressed wider economic and environmental impacts such as the impact of fires and lost agroforestry income. Van Beukering et al. (2008) estimated the dependency rate of palm oil on forests at 7.4%, that is the amount of the yield that can be attributed to forest services such as pest control, reduced erosion,

water supply regulation and pollination. Land prices, taxes and the valuation of ecosystem services that are lost due to palm oil plantations were variables not explicitly incorporated by the literature.

6. The NPV of palm oil per ha was calculated at various ranges for Indonesia: $960-$3340 (Grieg-Gran, 2008) and Kalimantan: $3,835-$9,630 (Butler et al., 2009). For the Heart of Borneo, the NPV as a whole for palm oil was estimated at ca. $4 billion, compared to opportunity costs of up to $3.4 billion in hypothetical carbon payments (Naidoo et al., 2009). The Benefit Cost Ratio (BCR) for palm oil for individual producers in Kalimantan was calculated at 1.59 (Belcher et al, 2004) and at 5.56 in Malaysia (Noormayahu et al., 2009). The zero burning technique for land clearing was found to generate higher initial costs but reduced future costs for palm oil (Gouyon and Simorangkir, 2002)

7. There was a single economic valuation study devoted to timber plantations (Maturana, 2005). It estimated the Total Economic Value (TEV) of 5 pulpwood companies with a cost-benefit analysis under optimistic and pessimistic scenarios, with combinations of increasing and declining pulpwood market prices and variations in total area planted. The benefits were calculated as the volume of production multiplied by the market price, whereas the total economic cost was determined by the product of the area logged times the Total Economic Value (TEV) of each hectare of forest lost to plantations, covering the value of all the ecosystem services the forest provides.

8. The estimated Benefit Cost Ratios (BCRs) for timber plantations under the study by Maturana (2005) were all below 1, except the plantation located on degraded land since no forests were lost to establish the plantation. The results show that timber plantations are detrimental for Indonesia as a whole, although they may be financially attractive for individual companies.

9. Various studies have carried out financial analyses comparing the NPV of conventional logging (CL) to reduced impact logging (RIL) in Borneo. All these studies compared various treatments in the field, looking at the financial returns of an initial harvesting operation and modeling a second one decades later (25-60 years) with forest simulation models. The selection of discount rates is very important given that there are only two flows of revenue in time.

10. Richter (2002) went farther and analyzed the entire economic impact of RIL vs. CL for a case study in Sarawak. This included the value of carbon stocks in non-production areas, the value of foregone forest products, of non-timber forest products and of the impacts on soil, recreation and biodiversity.

11. With a financial analysis, the NPV for logging is higher for CL than for RIL but highly sensitive to discount rates and harvesting efficiency. Under an economic analysis, the NPV over 40 years was higher for RIL. CL has a larger production in the first harvest: 44.5 vs. 27.8 m^3/ha, whereas RIL has a larger production in the second harvest. 23 vs. 83 m^3/ha, for data in Sarawak (Richter, 2002). In terms of costs, machinery costs were found to be 2.8x higher for CL than for RIL due to longer time of use and less planning (Natadiwirya et al. 2002). Hilly terrain places a limit on profits for RIL as compared to CL due to the larger areas excluded (Tay et al., 2002).

12. With data on the volume of illegal wood, Human Rights Watch (2009) estimated the lost revenue to the Indonesian government because of illegal logging, which consists of three sources: i) undercharged taxes by the government undervaluing the legal harvest with below market rates (unacknowledged subsidy); ii) tax evasion by illegal harvest; and iii) evasion by transfer pricing, when producers undervalue their exports. According to this study the Indonesian government lost $2 billion in 2006 alone.

13. There were only two studies relevant to financial analysis of coal mining in Borneo. Limberg (2008) looked at the incentives for conservation and conversion in the case of the Kutai National Park in

Kalimantan, where a section with massive coal deposits has been proposed to be excised from the park. Fatah (2008) examined the effect of coal mining on the economy of the entire province of South Kalimantan using a social accounting matrix, and carried out various policy simulations.

14. Limberg (2008) showed that the coal deposits provided a large incentive for conversion of Kutai NP as they have been valued at $92 billion. Fatah (2008) found that coal has a very low value added/output ratio: 0.2-0.3. The policy simulation shows that the regulation of small-scale miners achieves the best outcomes in terms of economy and the environment.

15. REDD payment flows are calculated in various studies for areas slated for conversion to palm oil plantations, to compare the NPV to that of palm oil, assuming that REDD payments are given for avoided deforestation at a historic or predicted rate. Carbon stock estimates are calculated with established guidance and variation due to forest type, soil type and elevation. Various carbon pricing options are considered by the studies, usually as part of a sensitivity analysis, ranging from market prices to marginal abatement costs or marginal damage costs. REDD transaction costs are incorporated by a few studies.

16. The NPV for carbon payments for REDD was estimated at 1.7-$3.4 billion for the Heart of Borneo (Naidoo et al., 2009) and at $10.7-$16.6 billion for the entire Kalimantan (Venter et al., 2009). The NPV per hectare varies significantly depending on the carbon price. With the voluntary market price the range is $614-$994, whereas with the price of carbon at the compliance market the range is $3,835-$9,630. Only at this latter range is REDD able to compete with the NPV of palm oil (Butler et al., 2009). The carbon price necessary to compensate returns to palm oil was calculated at $10-$33/ton on average, although prices of $1.6-$4.7/ton are cost-effective for peat areas with large carbon content in Kalimantan (Venter et al., 2009).

17. Among the literature reviewed, various studies have examined the financial and economic costs and benefits of conservation in Borneo and other tropical forest settings, examining scenarios that could make conservation most cost effective and economically justifiable. The most common measure of costs of biodiversity conservation were the opportunity costs of forest conservation, be it from logging, plantations or other crops. The most common valuation method for benefits of biodiversity was willingness to pay (WTP) estimates for ecotourism, conservation donations and bioprospecting. Both measures were used in cost-benefit analyses by different studies.

18. Wilson et al. (in Press) argue that biodiversity conservation costs in Kalimantan are overestimated when measured by opportunity costs and not by the costs of improved land use management that also provide conservation benefits. In that sense, improving management in protected areas and production forests is more cost-effective than trying to provide conservation only through expansion of protected areas. In a case study in a Biosphere Reserve in Paraguay, Naidoo & Adamowicz (2005) showed that only by including carbon payments does forest conservation pass the cost-benefit test against agricultural land uses. As a counterexample, for a forest reserve in Uganda, Naidoo & Ricketts (2006) showed that financing conservation would be possible simply by raising entrance fees to levels within the willingness to pay by tourists.

19. For other ecosystem services, the most comprehensive valuation undertaken in the region has been by van Beukering et al. (2008) for the forests in the Aceh province of Sumatra. The research evaluated the Total Economic Value (TEV) of forest ecosystem services in Aceh (water supply regulation, fisheries sustenance, flood protection, carbon sequestration, ecotourism, soil conservation, sediment retention, fire prevention, timber production, non-timber forest products and fire prevention), for both a scenario of deforestation and a scenario that preserves the existing forest cover. Other studies evaluated some of these services in different cases.

20. Van Beukering et al. (2008) employed the Impact Pathway methodology for ecosystem service valuation, which proceeds sequentially through the impacts of land use activities on the environment and its socioeconomic implications. The approach proceeds as follows: 1) Definition of study boundaries (impacts on ecosystem services and geographic boundaries); 2) Identification of economically significant physical impacts; 3) Quantification of significant socioeconomic effects; and 4) Calculation of monetary values and sensitivity analysis. The TEV of forests was the aggregate of these values. For all the ecosystem services, the valuation in step 3 proceeded as follows: 1) Calculation of dose response or dependency ratio of service on forest cover; 2) Quantification of the amount of shortages with the deforestation scenario; 3) Valuation of those shortages with market prices; and 4) valuation of substitution costs with surrogate prices or additional costs.

21. Cannon & Surjadi (2004) employed an alternative methodology to the TEV, the PREV (Participatory Rapid Economic Valuation), for valuing the loss in fisheries and tourism benefits caused by siltation and death of coral in the Togean islands near Sulawesi, in the event a logging concession was established in the islands. With the PREV, a full economic valuation is not required to produce a policy recommendation for a land use decision. PREV examines the benefits to the islands of the logging concession and then looked at the costs incrementally. If the costs soon surpass the benefits by a reasonable margin, there is no need to evaluate additional costs because it has been shown that the proposed project has a net detrimental effect.

22. The methodologies for financial analysis of palm oil plantations, conventional logging and reduced impact logging have been developed and replicated several times by different researchers with similar core procedures. The studies use Net Present Value and NPV per ha as the most important financial indicators. Financial analyses for these land uses have a thorough account of the private costs and benefits that need to be calculated and good datasets from palm oil companies, public statistics, field surveys and field experiments.

23. A regular omission in all the financial and economic analyses of palm oil, logging and timber plantations were the costs associated with the government, for both licensing fees for concession/plantation areas or taxes, with the exception of the illegal logging studies. These costs were not explicitly accounted for in most studies, which was surprising given that their variability should substantially affect profitability.

24. The literature shows that it is possible to determine the value of projected REDD credits with rigorous methodologies and spatial modeling, by assessing the carbon stock, valuing the opportunity cost of forest conservation in Borneo and estimating the possible benefits from payments for avoided deforestation and carbon sequestration.

25. There is still no standard methodology or agreement for valuing the costs and benefits of biodiversity conservation. Willingness to pay is frequently used as well as opportunity costs, although the latter may overestimate the costs of conservation, at least from a financial analysis perspective. Opportunity costs can also be lowered through policy levers like zoning, taxation and law enforcement, which leads to the conclusion that the costs of these policies should be included in the costs of conservation.

26. The main gaps for ecosystem service and land use valuation in Borneo, identified by their absence in the literature, are: 1) full economic valuation of palm oil plantations; 2) financial analysis of tree plantations from the perspective of the concessionaire; 3) modeling of RIL cost variability across Borneo and subsidies and incentives needed to make it financially attractive; 4) valuation of costs of policies for REDD and conservation implementation, including law enforcement and fire management; 5) financial analysis for coal mining in the island; 6) incorporation of taxes, licensing fees and land prices in models; 7)

valuation of many ecosystem service benefits: water supply, flood control, biodiversity benefits –e.g. for tourism.

27. It is recommendable to model the behavior of highly sensitive variables such as commodity and carbon prices, in order to understand the roots of their variability, so that they can be incorporated in future studies as dynamic variables.

28. Although several final values for NPVs and other indicators are given in this review, it is important to go back to each specific study to know how to use them appropriately, as none of them are directly comparable since the assumptions and parameters utilized were different.

29. Instead of attempting a Total Economic Valuation study for the Heart of Borneo, a valuation focusing on distributional analysis can provide greater value for advocacy and policy. A distributional analysis would look at the same land uses from different perspectives, clearly showing winners and losers and therefore being useful to design policies to reconcile the interests of different stakeholders.

30. For purposes of REDD, it is recommendable to study various policy scenarios. So far, the analyses have focused on estimating the impact of different carbon prices. Nevertheless, many other factors are uncertain and thus should be considered variable in the scenarios, such as the requirements of additionality, leakage and permanence requirements, the costs of REDD policies, among others. The financial and economic outcomes of REDD are very sensitive to various policy assumptions.

31. An ecosystem service valuation is rarely done in isolation, and often in response to worrisome land use trends or policy proposals for land use conversion. In that sense, its most important significance is comparative rather than absolute: not so much to answer the question of what is the exact monetary value of forests, but to inform the public of the potential net benefits or losses of different future scenarios of land uses and ecosystem conservation.

1. INTRODUCTION

This literature review was commissioned by the Heart of Borneo Network Initiative of WWF as preparatory work for a financial and economic assessment of land uses and ecosystem services in Borneo. This assessment, to be carried out in 2010, aims to highlight the value of forest services in Borneo and the need for sustainable financing mechanisms that recognize this value. The ultimate goal is to enable forest conservation to compete as a land use with the highly profitable agricultural and extractive industries that are causing forest destruction in Borneo.

The objectives of the literature review are: 1) to summarize relevant information on, and methodologies for, financial and economic analysis of logging, palm oil, timber plantations and coal mining in Borneo; 2) to summarize methodologies for both valuing forest ecosystem services and comparing them with the costs, benefits and impacts of extractive sectors; and 3) to identify and summarize the key findings of research that has been done in Borneo related to these topics.

The report is organized as follows: After an initial description of the methodology for the literature review, Section 3 describes the research on financial and economic analysis on each of the extractive land uses in Borneo that cause deforestation: palm oil, timber plantations, logging and coal mining. Section 4 describes economic and financial valuations of forest ecosystem services and conservation, with special focus on the valuation of carbon sequestration and biodiversity. Lastly, Section 5 discusses the methodologies, identifying research gaps in Borneo and giving suggestions for the assessment that WWF is preparing.

2. MATERIALS AND METHODS

A total of 24 journal articles and reports were selected for inclusion in the literature review, from an initial selection of 104. The initial selection consisted of articles found through searches with Google Scholar and Web of Science, referenced material in several journal articles. The final selection of 24 articles was based on thematic relevance (use of a methodology for financial and economic analysis), location (higher preference for studies in Borneo followed by other parts of Indonesia and Malaysia); thematic coverage (all major sectors had to be covered) and age (published from 2000 to 2010).

Of the 24 studies, 10 were carried out in Borneo (8 in Kalimantan, 2 in Sabah or Sarawak and 1 in the Heart of Borneo across Malaysia, Brunei and Indonesia). Four studies were from other parts of Indonesia (Sumatra and Sulawesi) and one from Peninsular Malaysia. There were also four studies refering to Indonesia as a whole, four to other parts of the world and one global study.

The following table describes the objectives of the ten studies that undertook financial or economic analysis of land uses and ecosystem services in Borneo:

Table 1. Financial and economic valuation studies of land uses and forest ecosystem services in Borneo

STUDY	OBJECTIVE
Naidoo et al. (2009) Economic benefits of standing forests in highland areas of Borneo: quantification and policy impacts.	Conduct rapid assessment of benefits of standing forests in the Borneo highlands (Heart of Borneo) to characterize values associated with forests in areas proposed for oil palm plantation development.
Venter et al. (2009) Carbon payments as a safeguard for threatened tropical mammals.	Estimate the possible REDD payments under various carbon pricing scenarios that could offset the opportunity costs of converting forest to oil palm plantations in the areas currently designated for conversion in Kalimantan.

Belcher et al. (2004). Rattan, rubber, or oil palm: Cultural and financial considerations for farmers in Kalimantan.	Compare financial costs and benefits of land uses by farmers in East Kalimantan: traditional rattan gardens, rubber production and oil palm.
Richter, F. (2002). Financial and economic assessment of timber harvesting operations in Sarawak, Malaysia	Carry out economic and financial cost-benefit analyses of conventional logging (CL) and reduced impact logging (RIL) for a logging operation with a 40-year rotation.
Natadiwirya et al. (2002) The financial benefits of reduced impact logging: saving costs and the forest. A case study from Labanan, East Kalimantan.	Compare the financial outcomes of CL and RIL methods, where RIL carries out pre-harvest inventories and produces detailed tree-position and contour maps for efficient skid trail alignment
Tay et al. (2002) Financial assessment of reduced impact logging techniques in Sabah, Malaysia.	Compare RIL with CL in terms of financial costs and benefits.
van Gardingen et al. (2003) Financial and ecological analysis of management options for logged-over Dipterocarp forests in Indonesian Borneo.	Compare standard selective logging and replanting system (TPTI) with RIL and alternative systems of yield regulation. Predict the likely timber yield, IRR and NPV of the management regimes.
Fatah (2008) The impacts of coal mining on the economy and environment of South Kalimantan Province, Indonesia.	Analyze the impact of the coal mining industry in South Kalimantan in terms of value added, output, employment, income distribution; and simulate effects of policies to reduce environmental impacts while maintaining good economic indicators.
Limberg (2008) Incentives to conserve or convert? Can conservation compete with coal in Kutai National Park?	Examine the potential for incentives for conservation in Kutai National Park and make the case for disincentives to conversion.
Wilson et al. (2009 in press). Conserving biodiversity in production landscapes.	Compare cost-effectiveness of conservation that includes alternative conservation strategies and accounts for the relative contributions of all land uses to conservation with a) protected areas as the single conservation strategy and b) opportunity costs of timber industry as a measure of the costs of conservation.

Further information on all the studies is found on the attached matrix Annex 1 (Excel file).

3. LITERATURE ON FINANCIAL AND ECONOMIC ANALYSES OF LAND USES

A. PALM OIL

Objectives of studies

In recent years there has been a surge of literature carrying out financial and economic analyses of palm oil in Malaysia and Indonesia. These studies typically calculate the financial, economic and environmental costs of deforestation for establishing oil palm plantations.

At a local scale, Noormayahu et al. (2009) modeled the output and financial returns of oil palm cultivation on peatland in Selangor, Peninsular Malaysia. Belcher et al. (2004) compared the financial costs and benefits of palm oil to farmers in Kalimantan with traditional rattan gardens and rubber production. For the Malaysian study, the authors wanted to understand the incentives leading farmers to cultivate oil palm in peatlands, whereas in Kalimantan they sought to explain the persistence of the seemingly unprofitable rattan gardens despite the huge profitability of the oil palm crop.

At a larger scale, various papers have carried out a comparative financial analysis of palm oil plantations and forest carbon payments in Sumatra (Butler et al., 2008) and Borneo (Venter et al. 2009; Naidoo et al., 2009), in anticipation of the passage of REDD in international climate negotiations. Naidoo et al. carried out the analysis specifically for forest areas in the Heart of Borneo threatened by oil palm plantation development, whereas Venter et al. examined areas of high and low suitability for the crop in the whole of Kalimantan. These studies are based on the premise that forest conservation financed by REDD payments needs to provide incentives to compensate the monetary returns that conversion to palm oil can give. Venter et al. (2009) employ a threshold of 50% of the opportunity costs. These opportunity costs were also calculated by Greig-Gran (2008) as an update for the Stern Review on the economics of climate change. She estimated the financial value of activities that lead to deforestation in various tropical countries. For Indonesia, the valuation was done for palm oil as it is the most profitable land use in deforested lands. The administration costs of REDD were added to the financial returns of those land uses and incorporated into the opportunity costs.

Other studies have estimated partial costs and benefits for palm oil crops. Guoyon and Simorangkir (2002) carried out a financial analysis comparing burning vs. zero burning methods for land clearing in palm oil and timber plantations. Van Beukering et al. (2008) included palm oil in their analysis of the economic impacts of deforestation on agriculture in Aceh. With the input of expert opinion, palm oil was estimated to have a dependency rate of 7.4% on forests, that is, the amount of the yield that can be attributed to forest services such as pest control, reduced erosion, water supply regulation and pollination.

Methodologies for financial analysis

For financial analyses of palm oil plantations, most studies calculated the financial costs and benefits of palm oil to the palm oil industry or small scale growers over the study area, be it at a small scale (Noormayahu et al., 2009; Belcher et al., 2004) or over a wide region in Sumatra, Borneo or Indonesia as a whole (Naidoo et al., 2009; Venter et al., 2009; Butler et al., 2009; Grieg-Gran, 2008). The financial costs and benefits were used to calculate the Net Present Value of palm oil over the study area, typically over a time span of 25-30 years using discount rates of 4-15% The local studies calculated additional financial indicators, namely the Benefit Cost Ratio (BCR), Internal Rate of Return (IRR) and returns to labor (Noormayahu et al., 2009; Belcher et al., 2004).

To calculate the Net Present Value of palm oil, all studies analyzed the oil palm through its productive lifetime (20-30 years) assuming a cycle of land clearing, planting, growth until maturity, onset of production (by years 3 to 5), increased production until years 15-20 and a production decline thereafter, with slight differences among studies. Some studies incorporated the financial benefits obtained from logging during forest clearing, as well as the harvest of annual crops like rice during the period of maturation and no production of the oil palm (Naidoo et al., 2009; Belcher et al., 2004; Grieg-Gran, 2008).

The wide scale studies relied on external sources for the information on profitability per hectare of palm oil. The local studies undertook field research, including questionnaires to farmers and surveys. Noormayahu et al. (2009) used this data in an econometric model and Cobb-Douglas production function to estimate the NPV. Spatial modelling was an important component of the Borneo studies in order to calculate geographic variations in palm oil yield and map the impacts of proposed palm oil on forest loss.

In all, the production cycle of palm oil in Indonesia and Malaysia has been well researched and the financial analyses carried out for various settings. Nonetheless, there are noticeable differences in the level of detail among studies, both in the disaggregation of the costs and revenues and in the consideration of varying scenarios of production levels, costs and revenues.

From the literature, the following table illustrates the variables that the studies considered when carrying out a financial analysis of palm oil and of timber plantations. It also indicates noticeable omissions in the literature. They may be important to consider for further financial analyses and may be hidden among some of the cost estimates that were employed by the various studies. The variables marked with a star indicate the ones relevant for a complete economic analysis of the economic value of palm oil and timber plantations to society beyond the financial cash flows:

Table 2. Variables for financial and economic analysis of palm oil and timber plantations

Variable	**Palm oil plantations**	**Timber plantations**
Deforestation rate	Either a historic value or a projected rate to clear a specific amount of land destined for plantations.	Used to calculate the area cleared
Area destined for conversion / Area planted	Plans for oil palm plantation development	Area allocated for timber concessions. Variability in area planted for sensitivity analysis.
Burning or zero burning	Cost differential implications of burning vs. zero burning for land clearing and during the production cycle, due to machinery use, land immobilization, presence of nutrients in soil after clearing and impact on pest control.	Cost differential implications of burning vs. zero burning for land clearing and during the production cycle, due to machinery use, land immobilization, presence of nutrients in soil after clearing and impact on pest control.
Logging/crop income at clearing	Important as logging provides a subsidy for the establishment of plantations during the first years without fruit production. Some farmers plant annual crops during this phase.	Natural forest logging harvest added to planted forest harvest.
Set up costs	Logging, clearing, peat drainage, road construction, holing and planting.	Ommitted. Only the incremental cost calculated for zero burning vs. burning.
Operational costs	Fertilizers, insecticides, herbicides, tools, labor.	Replaced by the opportunity costs of the TEV of the logged forests, or only the incremental cost calculated for zero burning vs. burning.
Production or harvest cycle	(25-30 years for Palm Oil)	Estimated for 54 years (Maturana, 2005)
Yields or harvested volume	On a yearly basis. One study differentiates between fresh fruit bunches (FFB), Crude Palm Oil (CPO) and palm kernels.	Includes wood harvested from natural forest, wood from planted forest and imported wood to supply pulp mill.
Yield variability (terrain, country, year-year)	During plantation lifetime, with terrain differences (e.g. peat vs. no peat) and land suitability, Malaysia vs. Indonesia, smallholder vs. plantation.	Dependent on the availability of natural forest, existent harvestable volume, area planted, survival factor and conversion rate of wood to pulp.
Weather related yield variability	Not explicitly included. Perhaps included with assumptions of yield averages. Refers to yield changes with respect to drought, fire, wet weather.	Not explicitly included. Perhaps included with assumptions of yield averages. Refers to yield changes with respect to drought, fire, wet weather.

Percentage of crop by grower and buyer	Not explicitly included. Smallholder vs. plantation, % destined to exports.	Assumed that both plantations and mills are monopolies.
Transportation costs	Not specifically included, perhaps because it is taken care of by crop buyers.	Not specifically included.
International market prices	Estimates by World Bank and FAPRI (Food and Agricultural Policy Research Institute. Usually CPO.	Market price of pulpwood (used as a shadow price for economic analysis, as the price from plantation to mill is kept low by a monopsony)
Local market prices	Price paid to farmers (by palm kernels, fresh fruit bunches or CPO).	Price from plantation to mill. Valid for financial analysis but not for economic analysis.
Discount rates	4% in Malaysia to 8-15% in Indonesia, justified by prevailing interest rates.	4-12%
Total Economic Value of forests that are lost*	The value of lost carbon sequestration and the additional costs of higher fire incidence. The impact on biodiversity has been ommitted.	Used TEV of logged over forests and of grasslands destined for plantation from external sources (Maturana, 2005). No description of what is included in the TEV is available.
Lost agroforestry income*	Income lost by replacing agroforestry crops with palm oil.	Not included
Impact on services downstream*	Ommitted (impacts on water quality, erosion control, fisheries, etc.)	Calculated in the TEV of forests lost. Assumes that all forest services are lost.
Land prices or concession leasing/licensing fees	Ommitted. Most likely because land is government owned. But land concession licensing fees are not mentioned either.	Ommitted. Most likely because land is government owned. But land concession licensing fees are not mentioned either.
Taxes	Not mentioned explicitly as a cost factor although it is an important policy lever that can be evaluated in different scenarios.	Not mentioned explicitly as a cost factor although it is an important policy lever that can be evaluated in different scenarios.

Scenarios and sensitivity analyses

Given the unpredictability of many variables into the future, some studies project various scenarios for the financial analyses of palm oil (Venter et al., 2009; Belcher et al., 2004). The scenarios represent high and low deforestation, high and low yield, and palm oil development in all areas or in only highly suitable areas. Similarly, most studies have sensitivity analyses to evaluate the impact of modifying several variables (market price, input and labor costs, interest/discount rates, plantation setup costs, logging income and % of land converted to palm oil) on the final calculations of NPV for palm oil. Many studies are cognescent of the large influence of discount rates on resulting NPVs and thus have various scenarios or sensitivity analyses with lower and higher values.

Economic analysis: externalities and distributional analysis

So far, no study was found that attempted to capture the change in Total Economic Value resulting from palm oil plantations in Indonesia or Malaysia, aggregating the entire set of social and environmental externalities of the crop, although various studies have valued some ecosystem services. The most studied negative externality of palm oil production is deforestation, and with it, the loss of biodiversity and increase in carbon emissions, whose costs were valued by Naidoo et al. (2009), Venter et al. (2009) and Butler et al. (2009) – see section on carbon sequestration. Gouyon and Simorangkir (2002) examined the costs of burning practices in terms of deterioration of soil nutrients and the opportunity costs of land immobilization – the time that the land is idle while people wait for it to dry in order to burn it for subsequent planting.

In terms of distributional analysis, Greig-Gran (2008) compared the NPV for smallholder crops and plantations, whereas Valencia (2009) estimated the possible income the government could earn from a proposed tax on palm oil exports in Indonesia. Naidoo et al. (2009) valued the benefits of palm oil for workers vs. owners of plantations, and also calculated the opportunity costs of lost income from agroforestry and the health and productivity costs for all of the island due to fires in the Heart of Borneo, whose probability would increase with conversion to palm oil plantations.

Highlights of results

All palm oil financial studies demonstrate that it is a highly lucrative activity, both for plantations and smallholders. In Malaysia, Noormayahu et al. (2009) obtained a very high Benefit Cost Ratio of 5.56 for farmers in Selangor, with an IRR of 40-67%, indicating that it is a highly beneficial investment. For farmers in Kalimantan, Belcher et al. (2004) also found a high BCR of 1.59. Surprisingly though, palm oil showed lower returns to labor than rattan, mainly because rattan demands little labor and has flexible harvesting times.

At a larger scale, both Butler et al. (2009) and Venter et al. (2009) find high profitabilities of palm oil (NPV per ha of $3,835-$9,630) in Sumatra and a total of $10.7-16.6 billion NPV for palm oil in Kalimantan, depending on the scenario. Grieg-Gran (2008) presents a lower estimate of $960-$3340 NPV per ha for Indonesia as a whole depending on scale and yield. For the Heart of Borneo specifically, Naidoo et al. (2009) calculated the benefits of proposed oil palm plantations: $3.7 billion for companies and governments together, and $0-226 million for local communities. These are large figures compared to the costs of fire ($17.5 million/yr) and agroforestry income loss ($9.9 -$11.4 million/yr). The costs in terms of carbon lost, however, are significant and comparable (Naidoo et al., 2009; Venter et al., 2009; Butler et al., 2009), between $1.7 and $3.4 billion –see section on carbon.

The potential revenue of a 1% Forest Conservation and Haze Prevention Tax on Crude Palm Oil exports for Indonesia was also significant: US$85.74-$142.9 million per year at prices between $600 and $1000/ton and 2008 production levels. (Valencia, 2009)

The results indicate that the Net Present Value is by far more sensitive to market price than to most other variables (Noormayahu et al., 2009; Belcher et al., 2004; Grieg-Gran, 2008). This shows that it is important for future financial analyses to establish plausible scenarios for market prices under different assumptions (e.g. increase in demand, variations in supply depending on land use regulation, etc.)

B. TIMBER PLANTATIONS

The finances and economics of timber plantations in Indonesia and Malaysia have not received as much attention in the literature as palm oil or logging, perhaps because they are a more recent phenomenon.

CIFOR (Maturana, 2005) was the only institution that conducted an economic valuation study of this sector, examining the total economic costs and benefits of five large pulp plantation projects in Sumatra, Indonesia. The study looked at 5 large pulpwood (HTI) plantation concessions in various Sumatra provinces designated for conversion into tree plantations. Maturana's intention with the study was to show the real economic costs and benefits of these plantations for the country, which go beyond any simple calculation of financial costs and gains for the companies.

Other studies dealt partially with forest plantations. PWC (2007) examined additional factors that improve performance of sustainable forestry with a case study in Brazil. Gouyon and Simorangkir (2002) compared the economics of the use of fire vs. zero burning methods when clearing land for industrial tree plantations in Indonesia and Malaysia.

Methods

Maturana (2005) undertook a cost-benefit analysis of the 5 pulpwood companies with optimistic and pessimistic scenarios, with combinations of increasing and declining pulpwood market prices and variations in total area planted. The analysis was done using three discount rates (4, 8, 12%) for a period of 54 years, from 1984 to 2038. The study generated benefit-cost ratios (BCR) for the five plantations and a total BCR for all the plantations together. The variables used in the study are listed in Table 1 above, together with the ones employed by Gouyon and Simorangkir (2002).

Economic costs

The total economic cost of each plantation was determined by multiplying the area logged by the Total Economic Value (TEV) of each hectare of forest lost to plantations, covering the value of all the ecosystem services the forest provides. The TEV of forests was taken from Siimangusong (2003) with a value of US$1283/ha for logged-over forest. In the case of highly degraded forests and grasslands the conversion costs were deemed much lower. The ecosystem services included in this TEV were timber, fuelwood and non timber forest product (NTFP) production, water supply, soil and water conservation, carbon sequestration, flood protection and water transportation functions, option value and existence value. Unfortunately, the text from Simangusong was unavailable to examine the methodology to obtain the TEV. This is a major caveat in assessing the robustness of this study.

Since the TEV estimate was always higher than the estimate of private financial costs, the TEV was assumed to subsume the private costs and was used as a flat cost for each hectare of forest logged. This is a drawback of the methodology, given that private costs should vary among plantations and should affect the benefit-cost ratios calculated. Another possible drawback is that Maturana assumes that all the TEV from the logged-over forest is lost with conversion to plantations, which is not necessarily the case. In addition, the original methodology for calculating TEV is not known and it is a very simplistic way of doing benefits and value transfer.

In examining fire costs, Gouyon & Simorangkir (2002) calculated the incremental costs and benefits of using fire vs. zero buring, with a cost-benefit analysis matrix for the NPV of plantations under both methods on three types of terrain and four types of vegetation. The cost components included were land clearing, plantation management, fertilizers and crop protection. Yield differences were examined as well as material inputs and the difference in nutrients left between burning and zero burning, proxied by the susbstitute cost of fertilizer.

Economic benefits

Maturana (2005) calculated the economic benefit of timber plantations by multiplying the volume of production by the market price of pulpwood. Again, the economic benefit to society is different from the financial benefit to the firm because plantation companies operate as monopsonies, where the plantation and the mills are owned by the same company and thus the mills set the buying price for pulpwood at a lower rate than the market price. Maturana argues that using the selling price of pulpwood from plantation to mill (eg. \$8/m^3) would grossly underestimate the economic benefits; hence she used the market price of pulpwood as a shadow price: \$40/m^3.

The volume of production used in the calculations includes wood logged from natural areas, harvested from plantations and obtained from other sources. The amount of these three sources of pulpwood depends on the availability of natural forest and the existent harvestable volume, in turn dependent on the area planted, the survival factor and conversion rate of wood to pulp.

Maturana explicitly excluded labor creation from the calculation of benefits, arguing that there was no net labor benefit to the economy as people were merely shifting from former economic activities. This assertion merits further scrutiny, however, as one would think that at least there are localized spikes in labor brought by the plantations that should count as economic benefits. Additionally, Maturana excluded from the benefit accounting the protection of conservation areas within concessions. She argues that the firms have not taken steps to prevent illegal logging in these conservation areas, so no net conservation benefits have been derived from the existence of the concessions.

The study included a sensitivity analysis with increasing and declining pulpwood prices and cultivated area.

Although the study by PWC (2007) did not follow traditional financial analysis, it listed factors that affect the financial performance of sustainable forestry: 1) natural features, 2) infrastructure and connections to markets and labor, 3) legal certainty over land, 4) political and economic conditions, 5) area in ha, 6) volume harvested 7) unit volume/ha/yr, 8) efficiency/net output ratio, 8) know-how in forest management, 9) duration of start-up phase, 10) FSC certification, and 11) timing of cash flows.

Results

In the CIFOR study, the results were conclusive: in 4 out of 5 cases the economic BCR’s are below 1, indicating that the HTI plantations generate more costs than benefits for society, except for one case where the plantations converted grasslands and highly degraded forest. These BCR ratios are not comparable to the ones for palm oil, however, as those for palm oil were derived exclusively from financial analyses of private costs and benefits, whereas the ones for timber plantations were derived from an economic analysis of societal impacts. They do, however, demonstrate the divergence in BCR’s when looking at an economic perspective rather than a financial one.

Gouyon & Simorangkir (2002) concluded that zero burning on mineral soils increases land clearing costs by \$50-\$150 per ha. Cost differences are higher on peat soils, hills and heavy forest. Zero burning however, reduces the need for fertlizers as there is a large cost to replace nutrients lost by burning, which range from 9% to 40% of total plantation costs.

C. LEGAL LOGGING

Objectives

The rich dipterocarp forests of Borneo are at the frontier of deforestation in Indonesia and are highly prized for their timber. Conventional logging (CL), both legal and illegal, causes substantial environmental harm beyond the removal of trees, is frequently inefficient in its operations and exceeds sustainable yields. Logging inflicts damage on residual vegetation, creates logging roads, increases erosion, sedimentation, affects water regulation and biodiversity.

Reduced Impact Logging (RIL) is an alternative to conventional logging, where timber extraction is carefully planned with a proper inventory of trees to fell, exclusion of environmentally sensitive areas such as steep slopes, and felling planning to minimize disturbance by falling logs and skidding, among others. Various studies have thus carried out financial analyses comparing CL with RIL in Borneo to understand the potential and limitations of RIL (Natadiwirya et al. (2001) and van Gardingen et al. (2003) in Kalimantan; Richter (2002) in Sarawak and Tay et al. (2002) in Sabah. All these studies examined an initial harvesting operation followed by a second one decades later (25-60 years). The Sarawak research went farther and analyzed the entire economic impact of RIL vs. CL. These studies showed that CL causes great environmental damage and is unsustainable in the long run, but is financially more beneficial for companies in the short term than RIL, although RIL has a better cost-benefit ratio for society as a whole.

Elsewhere in the literature, there are various instances of economic valuation of logging. Cannon & Surjadi (2004) used Participatory Rapid Economic Valuation to evaluate if a proposed logging concession in the Togean Islands in Sulawesi was economically beneficial, by calculating its benefits and then valuing its negative impacts on fisheries and tourism. Van Beukering et al. (2008) included the economic effects of both foregone logging and of the impacts of logging on other activities –see section on ecosystem services. Grieg-Gran (2008), Venter et al. (2009) and Butler et al. (2009) calculate the one-time logging benefits derived from clearing land for palm oil. Wilson et al. (In press) compared the cost effectiveness of conservation with the opportunity costs of logging, among others –see section on biodiversity conservation.

Methods

In the comparative studies of Conventional Logging vs. Reduced Impact Logging, Richter (2002), Natadiwirya et al. (2001), Tay et al. (2002) and van Gardingen et al. (2003), undertake a financial analysis of cash flows from the concessionaire's perspective for CL and RIL.

Natadiwirya, Tay and van Gardingen, with their respective collaborators, compare various treatments in the field of CL and RIL. Tay had four pairs of forest management units subjected each to RIL and CL, being careful in comparing very similar sites. Van Gardingen compared a particular form of conventional logging established in Indonesia (TPTI), with three RIL alternatives via a simulation model of forest growth. TPTI establishes a lower diameter limit of 50 cm for logged trees. The other three alternatives all followed RIL guidelines but had different harvest limits (by diameter limit, stems per ha and volume per ha). Natadiwirya et al. focused on evaluating the efficiency and logging productivity of bulldozers for both RIL and CL.

Apart from the study on bulldozer productivity, the others compared the returns of logging on the first harvest, the returns for the second harvest and the Net Present Value of CL vs. RIL. The production of the first harvest was calculated with field data, whereas the second one was estimated with forest growth models like DIPSIM – Dipterocarp Forest Growth Simulation Model (Richter, 2002; Tay et al., 2002). The selection of discount rates is very important given that there are only two flows of revenue in time. They range from 2-10% (Tay et al., 2002) to 16% (Van Gardingen et al., 2003), indicating usually rates of inflation in Malaysia and Indonesia.

From the literature reviewed, the following variables are important to consider when carrying out a financial analysis of conventional and reduced impact logging in Borneo:

Table 3. Variables for financial and economic analysis of palm oil and timber plantations

Variable	Conventional Logging	Reduced Impact Logging
Area logged	The entire area where logging takes place. Important for modeling second harvest.	Net production area (the net area logged after exclusion of sensitive areas). Important for modeling second harvest.
Excluded areas	N/A	Important to calculate impact on remaining forest ecosystem services
Land prices or concession leasing/licensing fees	Ommitted. Most likely because land is government owned. But land concession licensing fees are not mentioned either.	Ommitted. Most likely because land is government owned. But land concession licenses are not mentioned either.
Volume of wood harvested	Harvesting data from plots for first harvest and predicted second harvest with forest growth model	Harvesting data from plots for first harvest and predicted second harvest with forest growth model
Harvesting limits	Depends on the case, whether there is any limit or not	By volume, diameter, stems per ha.
Quality factor, utilization factor, log waste, harvesting efficiency	Parameters that affect the volume of logs sold from the volume of trees felled	Parameters that affect the volume of logs sold from the volume of trees felled
Volume of wood landed	Amount of wood landed at mills	Amount of wood landed at mills
Cutting cycle	Ranges from 25 to 60 years from first to second harvest	Ranges from 25 to 60 years from first to second harvest
Forest productivity	Important for model of second harvest	Important for model of second harvest
Areas logged, areas with roads, with soil compaction damage, with skid damage, damage to residual stand	Higher with CL. These affect the impacts on ecosystem services and also the production for the second harvest	Lower with RIL. These affect the impacts on ecosystem services and also the production for the second harvest
Operational costs	Road building, felling, topping, skidding, labor	Costs of CL + additional costs: prefelling inventory, road planning, staff training.

Additional costs of each method	More road building, more damage to residual stand, more machinery hours.	Planning, inventory, training.
Post-harvesting, processing and transportation costs	Similar costs	Similar costs
Royalties and taxes	Ommitted but important. By wood type, volume, processed or unprocessed.	Ommitted but important. By wood type, volume, processed or unprocessed.
Local timber prices and export prices*	Local prices may be different from market prices – the distinction is useful for economic analysis	RIL wood may earn certification preium prices. Richter (2002) used 10%.
Discount rates	2-16% (low for Malaysia, higher for Indonesia)	2-16% (low for Malaysia, higher for Indonesia)
Impact on ecosystem services of logged forests*	Non-timber forest products, soil, recreation, tourism,biodiversity, fisheries, carbon sequestration.	Non-timber forest products, soil, recreation, biodiversity, carbon sequestration.

For a more comprehensive economic analysis of timber production, Richter (2002) included the value of carbon stocks in non production areas assuming that carbon trading would occur; the value of foregone forest products; of non-timber forest products; the impacts on watershed protection to agriculture, settlements and fisheries through soil erosion, sediment delivery and increased runoff; and estimated recreation and biodiversity values, CL plots providing less value on these two fronts due to a higher disturbance. Cannon & Surjadi (2004) estimated the negative economic impacts of reduction in tourism and fisheries due to the impact of sedimentation on coral reefs due to logging. (See section on Forest Ecosystem Services).

Within the overall economic valuation study of forests in Aceh, when considering the benefits of timber production in a deforestation scenario, van Beukering et al. (2008) calculated them using a simple formula of production by price. However, when valuing the costs of not harvesting timber in a conservation scenario, the price difference of timber substitutes or of importing timber was added to the opportunity costs of conservation.

Results

The comparative studies showed that CL generates larger immediate profits for concessionaires than RIL, due to the higher amounts harvested (e.g. 44.5 m^3/ha for CL and 27.8 m^3/ha for RIL according to Richter, 2002), particularly in hilly terrain like in Sabah (Tay et al., 2002). This is done at the expense of sustainability, with the second harvest being substantially lower with CL than with RIL: e.g. 23 m^3 vs. 83 m^3 after 40 years (Richter, 2002). However, given the high discount rates, the NPV is still higher over 40 years for CL (Richter, 2002). Van Gardingen et al. (2003) show that RIL could perform better financially if harvesting efficiency improves.

The analysis by Natadiwirya et al. (2001) arrived to a different conclusion, although solely for machinery costs, by documenting that bulldozer use with CL was higher and thus 2.8 times costlier than with RIL, as the prior planning of skid trails in RIL reduces the need for machinery hours. Natadiwirya et al. (2001) argue that this is a very important finding since machinery hours are the major cost element in the harvesting operation.

A few studies carried out sensitivity analyses, showing that RIL can be made more competitive with CL with reduction in harvesting costs, increase in harvesting efficiency and/or carbon trading in non-production areas (Richter, 2002; Van Gardingen et al., 2003).

The comparative studies of CL and RIL were rigorous and comprehensive, and the financial analyses confirm than in the long term RIL is more viable than CL, although this finding is contingent upon the value of different factors, the chosen discount rate, and on the spatial setting.

D. ILLEGAL LOGGING

Objectives

Illegal logging is an immense environmental and criminal problem in Southeast Asia and accounts for a substantial part of the timber trade in Borneo. Only one study was found among the literature that focused on evaluating the costs of illegal logging for Indonesia (HRW, 2009). Hence, another study about illegal logging in the Amazon was reviewed for methodological purposes (Gutiérrez-Vélez et al., 2009).

In the report Wild Money, Human Rights Watch (2009) estimated the income lost by the Indonesian government because of illegal logging from 2003 to 2006. For the Brazilian, Peruvian and Bolivian Amazon, Gutiérrez-Vélez et al. (2009) attempted to carry out a wider economic analysis, estimating the costs of illegal logging to governments and society.

Methods

Gutiérrez-Vélez et al. (2009) defines illegal logging as the "non-legal selective harvesting and transport of logs from natural forests", excluding clearcutting and illegal logging from planted forests. It further distinguishes illegal logging due to place –logging occuring in areas where it is not legal–, and due to practice –logging in areas where it is legal but in excess of the legal amount. For HRW (2009), illegal logging is simply the amount of wood consumed that is over the legal supply.

Gutiérrez-Vélez et al. (2009) estimate the monetary costs of illegal logging as the difference in benefits derived from illegal logging from the benefits that would be derived from the same amount if it were done legally. HRW (2009) restricts its calculation of benefits to the lost revenue to the government.

To calculate the amount of illegal logging, the Amazon study uses various sources (share of illegal wood on total consumption and estimates from data on confiscated wood). The Indonesia study calculates the difference between the legal supply of wood (logging concession harvest + clearcuts + plantation harvest + imports) from the total wood consumption in the country in terms of its roundwood equivalent.

With data on the volume of illegal wood, Human Rights Watch estimated the lost revenue by the government, which consists of three sources: 1) Undercharged taxes by government undervaluing legal harvest with below market rates (unacknowledged subsidy); 2) Tax evasion by illegal harvest; and 3) Evasion by transfer pricing, when producers undervalue their exports. The latter step was calculated by "mirror statistics", comparing the value of exports reported by the Indonesian Ministry with the value of imports from Indonesia reported by importing countries.

In Indonesia, illegal wood is smuggled into Malaysia or also consumed locally, so this wood would not appear in the export records used to cross-check production vs. consumption. HRW (2009) recognizes also that some lost revenue is still not included: the evasion of other taxes, the losses to smuggling and the consumption of wood by small mills processing less than 6,000 m^3/year.

Although Gutiérrez-Vélez et al. (2009) only include unpaid royalties as the estimate of revenue lost to the government, they account for other additional costs of illegal logging compared to legal logging, with the assumption that illegal logging is more inefficient and environmentally damaging:

1) Missed appropriation of revenues (the revenue from the sale of timber that was lost by the actual owners of the forest, whether it is the government, a private landowner or an indigenous community);

2) Logging inefficiency – the differential of wood utilization by illegal vs. legal logging;

3) Loss of productivity of the land, reflected by a decreased future yield compared to what it would be with a legal operation;

4) Income loss due to depressed price of wood as a result of the increase of wood supply with illegal timber;

5) Unemployment – the employment differential of illegal vs. legal operations;

6) Difference in costs borne by loggers – the logging costs are deemed the same as for legal logging except for planning, inventory and royalties;

Results

For the Amazon study, the researchers estimated the cost of illegal logging over 30 years to be $558 million/year due to place, and $639 million/year due to practice. The largest costs are in lost royalties, amounting to $250 million per year.

HRW (2009) presents some stark figures for Indonesia. Using ITTO data, in 2006 alone the government lost $2 billion from illegal logging compared to only $0.3 billion assessed taxes. The figure drops to $1.2 billion using data from the Ministry of Forestry, which they deem as an underestimate. The province of West Kalimantan lost revenue equivalent to the entire provincial budget.

Studying the financial and economic impacts of illegal logging is a difficult undertaking that needs not only scientific but detective methods, so it is unrealistic to demand the same levels of precision as with legal logging or plantations. However, the lack of precision doesn't make the results less conclusive: the studies presented show that even with some margin of error there are huge losses for the government and society from illegal logging.

E. COAL MINING

Objectives

Among the literature only two studies were found that evaluated the economic impact of coal mining in Borneo. Limberg (2008) looked at incentives for conservation and conversion in the case of the Kutai National Park in Kalimantan, where a section with massive coal deposits was proposed to be excised from the park.

Fatah (2008) examined the effect of coal mining on the economy of the entire province of South Kalimantan and simulated the effects of various policies on the reduction of environmental impacts and the performance of economic indicators.

Methods

The study by Limberg (2008) is a very cursory comparison of the potential financial benefits to stakeholders in Kutai NP of the conversion to coal mining. It uses a single estimate of the value of the coal deposits in the area at its market price, comparing it with the financial benefits of conservation, namely water supply and carbon sequestration –see in Ecosystem Services Section. He does not account for the costs incurred in the exploitation of the coal nor discount the potential revenue throughout the years to derive the Net Present Value. In fairness, however, it is the only study reviewed that incorporated land speculation as a powerful economic incentive behind forest conversion in Borneo.

Fatah (2008) undertook a very different study, looking at the coal industry in the whole South Kalimantan province with a Social Accounting Matrix. The author employs an input-output structure for coal and uses provincial GDP and survey data to derive the following indicators: value added by coal mining, output generated, employment generated, production structure and interdependency, impact on income distribution and extent of leakage outside the province. He also derives figures for various environmental impacts (dust concentration, noise, erosion, land degradation, mining holes and earth disposal and vehicle density) through coefficients from expert sources.

Finally, Fatah evaluated various policy scenarios in South Kalimantan with different combinations of regulation, taxes and subsidies on the coal industry and investments in land cleanup and mine rehabilitation.

Results

Limberg (2008) showed that the anticipated conversion to coal in Kutai NP had brought a surge of land speculation, with the highest prices expected to be paid by coal companies for properties along the main roads. Unfortunately, the author makes no attempt to neither quantify the future revenue streams from coal exploitation nor document the costs of establishing the mine in the first place. In fairness, however, Limberg shows that the sheer magnitude of the coal deposit creates a powerful magnet for companies and settlers, even though there is little clarity as to how much money could be made how soon.

Fatah (2008) shows that in terms of value added, coal is the third sector of the province’s economy, but the ratio of value added/output is very low (0.2-0.3). He rightly points out that this indicator is very useful for policy makers to examine the efficiency of wealth creation. There is substantial leakage to other regions and the income benefits of coal are larger for non-farmers. The policy scenario favored is that of stricter regulation of small scale miners, which gives the least environmental impact and where there is some economic loss but it is small and borne mostly by high earners.

4. LITERATURE ON VALUATION OF FOREST ECOSYSTEM SERVICES AND CONSERVATION

A. CARBON SEQUESTRATION

Objectives

The promise of payments to tropical countries for Reduced Emissions for Deforestation and Degradation (REDD) has prompted various studies to quantify the carbon stock of tropical forests, the amount that is being lost through deforestation and the possible flow of payments given various future deforestation scenarios. Indonesia has received special attention given the very high rates of deforestation in the country.

In addition to the studies calculating the revenue from forest carbon payments as an alternative to oil palm plantations (Naidoo et al., 2009; Venter et al., 2009; Butler et al., 2009), other studies (Limberg, 2008; van Beukering et al., 2008) incorporated the estimation of REDD payments as components of the total economic value of forests in Aceh (van Beukering et al., 2008) and of forests converted to timber plantations in Sumatra (Maturana, 2005), as well as their value as possible incentives for conservation of Kutai National Park in Kalimantan (Limberg, 2008).

Estimation of carbon stocks

All estimates of revenue from avoided emissions from deforestation need to calculate the carbon stock existing in forests. Most studies that incorporated carbon stock estimates for the forest ecosystems in Borneo calculated them with established scientific guidance, including the IPCC (Butler et al., 2009), and Fargione (Venter et al., 2009). Limberg (2008) used an existing estimate of carbon stock for Kutai National Park from government sources from 2006. Naidoo et al. (2009) constructed a model between elevation and biomass with data from forest plots to establish a relationship between elevation and forest carbon, which could later be transferred to a map of the Heart of Borneo. Venter et al. (2009) employed an already existing forest carbon map of Kalimantan and distinguished between different sources of emissions: i) decomposition of timber, ii) burning of unharvested vegetation, iii) decomposition of unburned vegetation, iv) peat oxidation and v) increased probability of peat burning. Naidoo et al. (2009) and Butler et al. (2009) also subtracted the carbon content of oil palm to calculate the net carbon loss of forest conversion.

It is hard to assess the reliability of these carbon stock calculation methodologies and of the data employed, but it is fair to assume that the more recent guidance provides a more refined and precise methodology. The existence of a forest carbon map for Borneo is a great development (Venter et al., 2009) so it would be recommendable to review it in further detail, as well as other global carbon maps (Ruesch & Gibbs, 2008). In addition, Venter et al. (2009) was thus far the only study that explicitly incorporated the soil carbon stock in its emissions calculations, in addition to forest carbon. Peat deposits are a substantial source of emissions in Borneo by burning or oxidation, so it is very relevant to incorporate them in the carbon stock. However, it is unclear whether avoided emisions from peat will be eligible for REDD payments, so it makes sense to calculate them separately from the forest emissions.

Carbon prices

In calculating the projected revenue from REDD payments, various carbon pricing options are considered in the literature, usually as part of a sensitivity analysis. There are currently two sources of variability that need to be accounted for: the regular market variability of carbon prices and the variability due to the ranking of the carbon credits in the scale from voluntary offsets to compliance-grade credits.

Butler et al. (2009) examined the potential REDD revenue from various current carbon prices ranging from the voluntary offset credits, currently the cheapest and the only ones valid for REDD, to credits from the compliance market of the European Emissions Trading Sytem (ETS). This range of prices accounts for various policy scenarios, from the current situation to a scenario where REDD credits are interchangeable with compliance credits from the Kyoto market. The voluntary market price of carbon offsets was the price choice of van Beukering et al. (2008) whereas Limberg (2008) employed an unspecified market price.

Similarly, Naidoo et al. (2009) employed the tCER or temporary CER credit price, currently a kind of credit issued under the CDM for afforestation and reforestation that has to be reissued to account for the risk of carbon loss due to events like fires in forest. These credits receive a lower price than the standard CER credits and are currently not available for REDD.

Although the market price is an indication of the current social value of carbon, it may not indicate its full economic value. This is estimated by the Marginal Social Damage cost of carbon –the marginal cost to society of the impacts of climate change of one extra ton of carbon in the atmosphere–, which was used as a carbon price by Naidoo et al. (2009), Naidoo et al. (2006) and Chiabai et al. (2009); and the marginal abatement costs of carbon –the marginal costs to society incurred from taking action to reduce emissions by one ton–, which was used by Chiabai et al. (2009) as well. Since these costs are not firmly established, the authors used average or median values from estimates from the literature.

REDD payment streams

With data about carbon stock and carbon prices, REDD payment flows are calculated in the various studies in terms of their Net Present Value. Given a certain deforestation rate, a REDD project avoids that deforestation and receives payments periodically for the amount of forest carbon that would have been cleared in the absence of REDD. Butler et al. (2009) and Naidoo et al. (2006) evaluate upfront allocations of REDD payments, and Butler et al. (2009) also considers the scenario of staggered payments over 30 years. The discount rates employed range from 3% (Chiabai et al., 2009) to 15% (Naidoo et al., 2009) and the periods of assessment go from 30 to 43 years.

REDD payment streams being currently discussed within the international climate negotiations are payments for avoided deforestation, and not for the entire carbon stock of the forest, so as to meet the requirement of additionality. Hence, Butler et al. (2009), van Beukering et al. (2008) and Venter et al. (2009) employ deforestation baseline scenarios to indicate the amount of REDD credits available should the deforestation that would have occurred otherwise be avoided. In their papers, Butler, Venter and their respective collaborators calculate the baseline deforestation rate as a function of how much land is slated for oil palm development, whereas van Beukering et al. (2008) employs the current rate of deforestation in Aceh (1.3% per year). All studies looking at REDD scenarios assume that the entire forest is preserved and all the deforestation is avoided.

In realization of the requirement of additionality, Limberg (2008) indicates that REDD payment streams are not possible for Kutai NP if that requirement is maintained, given that the forests of Kutai NP are legally (although not completely in practice) protected, so there is no “additional” deforestation being avoided. Although additionality requirements are embedded in all analysis of REDD so far, the issues of leakage and permanence risk management are solely considered by van Beukering et al. (2008) among the studies reviewed in their REDD revenue calculations. The risk of permanence was characterized as a cost on insuring for permanence that is subtracted from the overall emissions avoided. The risk of permanence can be studied with proxies, for example by studying the risk of forest destruction in protected areas due to fires, logging and encroaching, where deforestation is supposed to be avoided at all times.

Butler et al. (2009) asserts that leakage can amount to 48-76%, but together with Grieg-Gran (2008), warn that their cost estimates are reliant on assumptions of 100% additionality and 0% leakage. Other variables that may affect NPV calculations are the earnings from interest, which Butler et al. (2009) does not consider and other studies fail to mention as well.

The transaction costs of REDD projects (start-up and administration) are considered by Naidoo et al. (2009), Butler et al. (2009) and van Beukering et al. (2008), measured in costs per ton of carbon or ha. Grieg-Gran (2008) derives admininstration costs of REDD from costs of national PES payment schemes in Costa Rica and Mexico, where governments pay forest landholders to preserve forests.

As an innovative part of their analysis, Venter et al. (2009) create an important measure of cost effectiveness for REDD payments, showing that given the variability of carbon stock across Kalimantan and its very high concentrations in peatlands, the cost of avoiding emissions per ton of carbon fall susbtantially in peatlands, as these hold much more carbon per ha, making it cheaper to compensate for the opportunity costs of palm oil per ha.

Sensitivity analyses

Carbon price, biomass levels and discount rates are the main variables considered in the sensitivity analyses carried out by the different studies (Naidoo et al., 2009; Venter et al., 2009; Butler et al., 2009; van Beukering et al., 2008). Butler et al. (2009) added REDD maintenance and set-up costs. Limberg (2008) did not include a sensitivity analysis.

In all, the following variables are important to consider when valuing the potential revenue from REDD according to the literature. Ommissions from the literature **are** also highlighted:

Table 4. - Variables for estimating carbon payments through REDD

NEEDED TO CALCULATE BENEFITS	NEEDED TO CALCULATE COSTS	POLICY ASSUMPTIONS
Carbon stocks aggregated or disaggrgated by carbon pools (varying by type of forest, soil, elevation)	Transaction costs of REDD - Set up and operational costs at project level.	Additionality requirements
Carbon price (market price(s) from voluntary and compliance markets, MDC, MAC)	Cost of monitoring deforestation at national level (Ommitted).	Permanence risk (through fire, encroachment)
Deforestation rate	Costs of policies to limit deforestation (PES, sectoral policies, fire management) (Ommitted).	Leakage evaluation. Ommitted.
Delivery of payments (upfront or staggered)	Law enforcement costs (Ommitted)	Interchangeability of REDD credits with other credits
Discount rates (3 to 15%)		Additional requirements for sustainability (REDD+) (Ommitted)
Revenue distribution among stakeholders (Ommitted). *Indonesia issued a decree for REDD revenue sharing*		Matching opportunity costs of palm oil or other.

Results

Naidoo et al. (2009) estimated that if all the land scheduled to be converted into oil palm plantations in the Heart of Borneo was destined for carbon storage, it would generate $1.7-$3.4 billion in hypothetical payments. Unfortunately, this is still lower than the $3.7 billion estimated benefits from oil palm plantations, although the benefits for palm oil are highly concentrated among companies and the government.

A similar conclusion was arrived at by Butler et al. (2009), who found that converting a hectare of forest for palm oil production in Sumatra would be more profitable (yielding net present values of $3,835–$9,630) to land owners than preserving it for carbon credits (NPV: $614–$994) if trading occurs only at the voluntary carbon market level. Only by raising REDD credits to compliance-level credit prices would its profitability be comparable: NPV $6,605.

Following its conclusion that Kutai NP would not be eligible for REDD payments, Limberg (2008) concluded that there is an impossibility of competing with coal mining in areas to be excised from the reserve. However, if areas are to be excised they could probably claim additionality status for REDD.

Venter et al. (2009) had a much more positive outlook on the potential for REDD. They argued that although REDD payments to offset the opportunity cost of palm oil in Kalimantan would need carbon prices between $10 and $33 per ton, due to the high cost-effectiveness of conserving carbon stocks in peat forest areas, the necessary price to match the opportunity costs there would drop to $1.63-$4.66 per ton.

B. BIODIVERSITY

Objectives

The rainforests of Borneo are one of the most biologically diverse areas of the planet. Unfortunately, they have been chronically undervalued by the land use decisions that favor deforestation over forest conservation. Although biodiversity has economic value for tourists that want to see wild animals and plants, pharmaceutical companies that might benefit from compounds from the rainforest, and the international community that wants to preserve species for their existence value; the absence of economic values from biodiversity that could be easily captured by the local population favors the destruction of the rainforest.

Biodiversity conservation as a form of land use refers to the designation of protected areas and the active management of lands for the protection of wildlife. The costs related to protected areas are land prices (if the land is purchased), administration, patrolling, staffing, equipment and research, and emergency response, such as firefighting, among others. However, the highest cost is perhaps the opportunity cost of setting aside areas out of production, that is, the lost revenue from the alternative activity that could yield the largest profits.

Among the literature reviewed, various studies have examined the financial and economic costs and benefits of conservation in Borneo and other tropical forest settings, examining scenarios that could make conservation most cost effective and economically justifiable.

Wilson et al. (in press) examines the costs of conservation across East Kalimantan, accounting for the contribution of both protected areas and unprotected lands to conservation, with the observation that areas like forest concessions and degraded land still represent viable habitat for certain species. This observation is similar to the one by Richter (2002), which used a reference from the literature indicating that the biodiversity value of a forest is reduced by 30% under RIL and 50% under CL.

Robin Naidoo, in two studies with different collaborators (Naidoo & Adamowicz, 2005; and Naidoo & Ricketts, 2006) carried out a spatial cost benefit analysis for biodiversity conservation in protected areas and surrounding areas in Uganda and Paraguay. In Uganda, the study evaluated the potential of a tourism market mechanism to fund conservation based on species diversity. In Paraguay, they valued ecosystem services – carbon sequestration, biodiversity existence and bioprospecting value, sustainable timber and bushmeat harvesting– and the opportunity cost of agricultural land use spatially across a biosphere reserve. Limberg (2008) analyzed the incentives for conservation and for conversion in Kutai National Park in Kalimantan, not just the economic but also the career and image incentives for various stakeholders: businesses, government officials and the local population.

Chiabai et al. (2009) aimed to provide an accurate per hectare estimate of the economic value of some ecosystem services, including biodiversity, for all forest biomes in the planet.

Methods

Costs of conservation

In order to estimate the costs of conservation, Wilson et al. (in press) first mapped the ranges of 1077 mammal species, combined them and determined the priority areas to achieve conservation targets, employing coefficients of suitability for different land uses considered: production forest, production forest with RIL, protected areas and protected areas with improved management. Four scenarios of different land uses were created to evaluate the costs to achieve the same level of conservation.

In that same study, the costs of conservation were valued for each different land use. For protected areas, there is a cost of conservation management, whose value was estimated from TNC budgets from the region ($6/ha). For Reduced Impact Logging, there is an additional cost in training at $11/ha, whereas converting formerly production forest into protected areas incurs additional opportunity costs, whose values were obtained from Venter et al. (2009). Naidoo & Adamowicz (2005) and Naidoo & Ricketts (2006) did not incorporate conservation management costs but defined the costs of biodiversity conservation simply as opportunity costs, that is the foregone rent of agriculture (the most profitable land use) multiplied by the land price, where rent is the expected profits from agriculture. The rationale for this is that designating a new protected area removes the future option value of the site for agriculture, logging and other production uses. The opportunity costs in areas already designated as strictly protected is deemed to be 0, as there is a legal impossibility to carry out agriculture, logging or other extractive activities there.

Benefits of biodiversity

In environmental economics, biodiversity is frequently valued by the willingness to pay (WTP) for the conservation of that biodiversity. This value is different depending on who is deemed to be interested in paying for conservation, whether it is the international community, foreign tourists, local tourists, among others. Often, these WTP values are aggregated to obtain an overall economic valuation of biodiversity benefit. Chiabai et al. (2009), in a global study, employed a multivariate regression of WTP estimates from numerous studies, indicating that both the size of the forests and local income were the main statistically significant factors affecting the WTP values. They used this relationship to estimate the marginal WTP value for different types of forests in different countries.

Naidoo & Ricketts (2006) employed the WTP for conservation by the international community, measured by the value of debt for nature swap per annum per household per hectare, as a measure of the biodiversity value of forests. Van Beukering et al. (2008) took a current forest conservation project in Aceh by Fauna & Flora International as a proxy for the international WTP for preserving the existing forests in Aceh. To that, the authors added the willingness by tourists to donate to conservation activities, as measured with a survey of tourists of Leuser National Park in Sumatra. Naidoo & Adamowicz (2005) used a similar metric to calculate the value of a forest reserve for biodiversity tourism, combining a survey of visitors to Uganda with actual visitation statistics of the forest reserve, employing an econometric model to verify the predictability of the survey results. In order to compare the marginal value of biodiversity between two reserves with different numbers of bird species, the authors compared the survey results for both reserves.

In addition to WTP for biodiversity conservation, pharmaceutical companies value biodiversity for their expected use value for extracting compounds for pharmaceutical use. There are various studies that document the WTP by these companies to have access to rainforest areas for bioprospecting. These values are used by Naidoo & Ricketts (2006) and Van Beukering et al. (2008) as part of their economic valuation of biodiversity. The latter, for instance, use a conservative estimate of $1 /ha/yr as bioprospecting hasn't been as economically prosperous as previously thought.

Naidoo & Ricketts (2006) was the only study that included bushmeat as a biodiversity benefit. It valued it by estimating the amount of bushmeat a forested area would provide and using beef price as a surrogate price. There was a threshold size for forest plots to produce bushmeat, so the spatial modeling was able to incorporate fragmentation as a cost in this respect. The value of biodiversity is diminished with fragmentation, increased access to hunting, pollution, sedimentation and other impacts. For this reason, it is important to depict variations in biodiversity integrity spatially under various scenarios when assigning economic values to it across a landscape

No other studies among the ones reviewed attempted to value other consumptive uses of biodiversity, such as poaching and wildlife trade in Borneo. Neither was there a specific valuation if biodiversity as a supportive service of other services, like forest productivity of Non-timber forest products.

<u>Scenarios of cost-effectiveness of conservation</u>

The different scenarios Wilson et al. (in press) consider to compare the costs of conservation incorporate land use changes and changes in the assumptions: 1) a full zoning scenario with new protected areas, Reduced Impact Logging occurring in all concessions, and existing protected areas having an improved management; 2) similar to Scenario 1 but without RIL; 3) only protected areas are assumed to be of any conservation value in all the land use matrix; and 4) regardless of the land use, the costs of conservation are always deemed to be the opportunity costs of forest conservation ($2,634 per ha per year). The analysis is carried out over 30 years at a 4.4% discount rate.

As for the other studies, Naidoo & Adamowicz (2005) evaluate from a cost benefit analysis standpoint the point where benefits from biodiversity tourism meet costs, and find how many species could be protected in the forest reserve in Uganda at that level. Similarly, Naidoo & Ricketts (2006) assign costs and benefits of conservation spatially and evaluate which parts of the landscape are worth preserving for economic reasons.

Results

In the study by Wilson et al. (in press), the authors calculate that scenario 1 achieves conservation targets at a lower cost ($1.22 billion over 30 years) because fewer additional protected areas are needed and conservation benefits are obtained mostly from improved management of all land uses. In scenario 3, where non-protected areas are assumed to be of no value for conservation, the cost of conservation is very high ($19 billion) because many more protected areas have to be created to reach the same goals. In scenario 4, the figure is 7.5 billion, indicating that when opportunity costs are used to value the costs of conservation, these are apparently very high.

The results for the biosphere reserve in Paraguay (Naidoo & Adamowicz, 2005) indicate that the cost-benefit test of conservation is only passed in 19% of forests outside the core protected area, considering bushmeat, sustainable timber harvesting, bioprospecting and existence value as the ecosystems services of value. Only when carbon sequestration as a service is incorporated into the mix can conservation surpass the opportunity costs of agriculture in the rest of the forested areas.

In the case of the forest reserve in Uganda, Naidoo & Ricketts (2006) found that simply by revising the entrance fees from $5 to $47, following tourists' willingness to pay, and redistributing ecotourism revenues; this would be sufficient to protect the habitat of 114 of the 143 forest species.

In their global study, Chiabai et al. (2009) calculated a marginal value of €59/ha/year of willingness to pay for conservation of forests in Southeast Asia, according to the value transfer protocol employed.

C. OTHER ECOSYSTEM SERVICES

There were few economic valuation studies of other ecosystems services beyond biodiversity and carbon sequestration in Borneo.

In Indonesia, however, the most comprehensive economic valuation study of forest ecosystems in the literature was done by van Beukering et al. (2008) for the forests in the Aceh province of Sumatra. The research evaluated the Total Economic Value (TEV) of forest ecosystem services in Aceh: water supply regulation, fisheries sustenance, flood protection, carbon sequestration, ecotourism, soil conservation, sediment retention, fire prevention, timber production, non-timber forest products and fire prevention; for both a scenario of deforestation and a scenario that preserves the existing forest cover. Similarly, Cannon & Surjadi (2004) valued the loss in fisheries and tourism benefits caused by siltation and death of coral in the Togean islands near Sulawesi in the event a logging concession was established in the islands.

Van Beukering et al. (2008) employed the *Impact Pathway* approach when valuing the impact of deforestation on ecosystem services. The Impact Pathway methodology proceeds sequentially through the impacts of land use activities on the environment and its socioeconomic implications, although only looking at first order effects. The approach proceeds as follows: 1) Definition of study boundaries (impacts on ecosystem services and geographic boundaries); 2) Identification of economically significant physical impacts; 3) Quantification of significant socioeconomic effects; and 4) Calculation of monetary values and sensitivity analysis.

An important clarification is that the Aceh study measured the marginal impact of deforestation or conservation on various ecosystem services, not the entire Total Economic Value of those services but the contribution that forests make to them. For all the ecosystem services, the valuation in step 3 proceeded as follows: 1) Calculation of dose response or dependency ratio of service on forest cover; 2) Quantification of the amount of shortages with the deforestation scenario; 3) Valuation of those shortages with market prices; and 4) valuation of substitution costs with surrogate prices or additional costs.

Water supply

The only reference to valuation of water supply services in Borneo in the studies reviewed is from Limberg (2008) for Kutai National Park. To calculate the value of this service, he used estimates from other sources on water usage in the surrounding region, and used the market price of water to value the service at $125,000/year.

In Aceh, van Beukering et al. (2008) employed the dependency ratio of water supply from forests, obtained from the literature; and quantified the market value of estimated water shortages with a deforestation scenario with the corresponding market price. To that, the additional costs of substituting for shortages were added (transport costs of water from other areas).

Non-timber forest products

Van Beukering et al. (2008) valued NTFP for Aceh estimating production quantities and prices for 3 types of products of low, medium and high value. Their market value was calculated in terms of collected quantity and price advantage compared to substitutes.

Fire prevention – Biomass pollution retention

In Aceh, van Beukering et al. (2008) valued the fire prevention service of forest conservtion by answering the question: What would be the damage from fires if Aceh forests were degraded? Hence, the value for fire prevention was placed in terms of avoided damage. The authors used data from fire occurrence in degraded and intact forests from the 1998 fires in Indonesia.

Although he did not provide a valuation of the service, Valencia (2009) defined the service of *"biomass pollution retention",* attributable to forests and peatlands given a land use without fire. This service yields the benefit of healthy air quality and prevents the damages associated with haze. Forests store the biomass pollutants present in haze as long as they are not burnt. He suggested valuing this service by looking at the damages incurred when there is a haze episode and the service of biomass pollution retention is not operating.

Fisheries

Cannon & Surjadi (2004) estimated that there would be a 50% reduction in fish catches in the Togean Islands, with a market value of $2.3 billion, given a 50% reduction in the coral reef area, due to the estimated impact of siltation due to logging. This dependency ratio was extracted from the literature.

Similarly, van Beukering et al. (2008) employed other dependency indices of fisheries on forests, obtained from the literature andvarying by type of fishery, and estimated the catch loss and corresponding market value. The estimated additional costs of price increases and substitution costs from aquaculture production were added.

Flood protection

This service was only evaluated by van Beukering et al. (2008) among the studies reviewed. Using a conservatively low dependency ratio on forests, the authors used a damage function in a deforestation scenario to value the additional damages from floods to residences, agricultural production and infrastructure arising from deforestation. The authors concede that the literature is not in agreement about the strength of the link between forest protection and avoidance of damage from floods, so they were prudent in their valuations of the contribution of forest services to flood protection, using a 14% dependency ratio.

Soil conservation and sediment retention

Van Beukering et al. (2008) derived a dependency ratio of the generation value of hydroelectricity from forest services, as a result of water flow regulation and sedimentation control. This ratio was 22%, meaning that 22% of the electricity generated can be attributed to the services provided by the forests. To that, the authors added the additional cost of repairs to hydroelectric installations due to predicted siltation damage as a result of deforestation.

In analyzing the full economic impact of conventional logging and Reduced Impact Logging, Richter (2002) employed an index from the literature valuing the remaining ecosystem service of sediment retention in a forest subject to logging compared to an untouched forest. According to this index, 20% of this ecosystem service remains after RIL, whereas only 5% remains under CL.

Forest services to agriculture

Van Beukering et al. (2008) valued in aggregate the impacts of deforestation on agriculture by the negative impact on forest ecosystem services: increased flooding, reduced pest control and pollination, erosion, droughts, reduced in yield, increase in crop area, increase in production costs. Dependency rates for rice, fruits and vegetables and palm oil were carefully estimated by expert opinion at 14.8, 11.2 and 7.4%; that is, the rate at which agricultural yield depends on the forests.

D. AGGREGATE VALUATION OF ECOSYSTEM SERVICES

Total Economic Value (TEV) of forests

For the study of Aceh's forest, Van Beukering et al. (2008) define the TEV of forests as the aggregate value of forest services to different sectors available under the two scenarios (agricultural production, water supply, flood prevention, fisheries production, carbon sequestration, non timber forest products, sedimentation control, hydroregulation, biodiversity, timber and fire prevention). The deforestation scenario assumed a deforestation rate of 1.3% per year, no ecotourism revenue and no funds for conservation nor for carbon sequestration. The conservation scenario assumes the opposite: no deforestation, no timber revenues, and maximum development of ecotourism and of carbon and conservation funds. In the deforestation scenario, the TEV of forested areas is the timber production and agricultural production in cleared land, plus the ecosystem services that are generated by the areas that remain forested, minus the losses in ecosystems services as a result of the loss of some forests. In the conservation scenario, the TEV of forested areas is their total ecosystem service value, including carbon, tourism and biodiversity, except for timber production, as there is no timber extraction.

Maturana also employed the TEV of forests that were logged to give way to timber plantations in her calculations of the TEV of timber plantations. Unfortunately, the TEV was sourced from Siimangunsong (2003), whose work was not available for review.

Rapid Economic Valuation

As an alternative to the calculation of the TEV of forest services in a given area, Cannon & Surjadi (2004) use an alternative methodology, an explicit partial economic valuation called Participatory Rapid Economic Valuation (PREV).

The authors argue that economic valuation can be used to respond to policy proposals of land use decisions that cause environmental impacts, and ought to be rapid enough to have an impact in these policy decisions. At the same time, valuation results must be credible, simple and easily understood. This means that assumptions should be considered reasonable and the data perceived as accurate by the main stakeholders and decision makers. The benefits and impacts to be examined, as well as the methods and assumptions, are validated with experts and policy makers.

Cannon & Surjadi (2004) used the PREV in the Togean Islands in Sulawesi in order to value the benefits and costs of a proposed logging concession. With the PREV, a full economic valuation is not required. PREV examines the benefits to the islands of the logging concession and then looks at the costs incrementally. If the costs soon surpass the benefits by a reasonable margin, there is no need to evaluate additional costs because it has been shown that the proposed project has a net detrimental effect.

A similar partial economic valuation, albeit not explicitly participatory, was used by Naidoo et al. (2009), Venter et al. (2009) and Butler et al. (2008) to evaluate the proposed impacts of palm oil. Not all impacts were studied, but as Naidoo et al. (2009) pointed out, the demonstration that potential carbon benefits are significant from forests that were designated for palm oil plantations appeared to be an important factor in shelving the proposal to designate a massive corridor in Kalimantan for palm oil plantations.

5. DISCUSSION AND RECOMMENDATIONS

A. FINANCIAL ANALYSES OF EXTRACTIVE LAND USES

The methodologies for financial analysis of palm oil plantations, conventional logging and reduced impact logging have been developed and replicated several times by different researchers with similar core procedures. The studies use Net Present Value and NPV per ha as the most important financial indicator. For palm oil, studies look at plantations throughout their life cycle with yearly income streams, whereas for logging concessions the studies focus on two discrete harvest times. Financial analyses for these land uses have a thorough acount of the private costs and benefits that need to be calculated and good datasets from palm oil companies, public statistics, field surveys and field experiments.

For financial analyses of illegal logging, the greatest difficulty lies in calculating the amount of illegal wood supply. However, recent technology developments may make it easier to estimate the amounts of illegal wood. There are now remote sensing instruments that can detect selective logging, which could be superimposed to legal logging concessions and hence estimate the spatial extent of illegal logging. With ground truthing with field plots there could be assessments of the amout of wood extracted illegally. Additional forest plots and observations in legal areas may help estimate the amount of wood logged illegally due to practice.

Many studies undertake sensitivity analyses, which are indispensable to evaluate the sensitivity of the results to changes in values of different factors. It is good to see that discount rates, which directly affect the NPV calculation, are included regularly in the sensitivity analyses so that the reader can judge the results with different discount rates. Given that commodity prices are among the variables to which results are most sensitive to, it would be highly recommendable to understand the behavior of prices and model their variability, so that they could be incorporated in the studies as dynamic variables.

With just one complete study on the economic value of timber plantations from Indonesia, there is much work to be done in other settings to replicate and validate this analysis. It would be important to review studies on financial performance of tropical tree plantations in other locations to examine the financial cash flows from the perspective of plantation companies, much as is the case with palm oil studies. This is more difficult, however, as plantation management varies by the species of tree planted, the main destination of timber, whether for hardwood, pulp or other wood products, and the criteria for management, whether it follows sustainable forestry practices or not.

A significant gap in the literature is that of methodologies and case studies for financial analysis of coal mining operations in Borneo. There are surely financial analyses for coal mining in other parts of the world which could be applicable to Borneo, although it is important to know which kinds of operations are more analogous to the ones occurring in the island.

B. ECONOMIC ANALYSES OF EXTRACTIVE LAND USES

Maturana (2005) provided a good example of the difference between an economic analysis of a land use as compared to a financial analysis, by including the economic benefits and costs of timber plantations regardless whether there is a cash flow associated to it. The additional benefits that do not appear in financial analysis were primarily the differential between local and international prices and the environmental impacts of the lost ecosystem services of the areas that were cleared to establish the plantations. For the latter, Van Beukering et al. (2008) demonstrated the usefulness of the Impact Pathway Approach to valuing the impact of deforestation in monetary terms.

Nonetheless, the environmental impacts and social externalities do not end when the forest is cleared but occur throughout the life of the plantation. Additional impacts like water polllution, increase in the risk of fire, and water supply impacts need to be valued on top of the lost ecosystem services, in order to arrive at more comprehensive economic analyses of land uses. For conventional and reduced impact logging in Borneo, the most comprehensive economic analysis is done by Richter (2002); for palm oil, by Naidoo (2009). However, these cannot be called Total Economic Value analyses as many environmental and social impacts are not valued.

A regular omission in all the financial and economic analyses of palm oil, logging and timber plantations were the costs associated with the government, for both licensing fees for concession/plantation areas or taxes, with the exception of the illegal logging studies. These costs were not explicitly accounted for in most studies, which was surprising given that their variability should substantially affect profitability.

The methodology used by Fatah (2008) for the economic analysis of coal was very different, as it focused on the contribution of coal mining to the provincial economy in aggregate. The analysis serves a different purpose than Total Economic Value studies and it is useful to reveal the weight of different sectors that contribute to deforestation in different provinces. It is not appropriate, however, to value the environmental and social impacts that do not get recorded in government statistics.

C. ECONOMIC VALUATION OF ECOSYSTEM SERVICES AND CONSERVATION

Ecosystem service valuation is rarely done in isolation, and often in response to worrisome land use trends or policy proposals for land use conversion. In that sense, its most important significance is comparative rather than absolute: not so much to answer the question of what is the exact monetary value of forests, but to inform the public of the potential net benefits or losses of different future scenarios of land uses and ecosystem conservation.

The literature reviewed on ecosystem service valuation can be divided into two streams: On the one hand, some studies look at the marginal impacts of a change in land use in current ecosystem services. These studies examine the costs of losing ecosystem services. Van Beukering et al. (2008) studied the marginal impact of deforestation in fisheries, water supply, agricultural production among others. Cannon & Surjadi (2004) examined the marginal impact of logging on fisheries and tourism. On the other hand, other studies focus on valuing the benefits of preserving the forest for its ecosystem services –and the financial costs of conservation– and compare them against the opportunity costs of forest conservation (profitability of logging, conversion to palm oil, timber plantations or other agricultural uses). These studies carry out a cost benefit analysis across the landscape, concluding whether it makes financial or economic sense to preserve the forests, in addition to other scientific and ethical justifications.

To value the impact of land uses on ecosystem services, the Impact Pathway Approach used extensively by van Beukering et al. (2008) is a very reasonable method which accounts both for the costs of services that are lost (e.g. diminished fish catch) plus the added costs of substitution for that loss (imported fish or production from aquaculture). This methodology requires dependency ratios indicating how dependent a given service is on the forest. Although it is difficult to provide accurate coefficients of some of these dependency ratios, the use of conservative estimates of these ratios from the literature ensures that the monetary impacts on ecosystem services are not inflated.

The Impact Pathway Approach methodology could be very useful in Borneo to evaluate the impact of land use changes on water supply, fisheries, soil conservation and flood prevention, among other services. Given the likely data limitations on these services and the difficulties of integrating data from Malaysia, Brunei and Indonesia, it would be difficult to achieve similar levels of precision as for valuation of palm oil or carbon sequestration.

Carbon sequestration

As an example of the opportunity cost methodology, several studies examined, in particular Naidoo et al. (2009), Venter et al. (2009), and Butler et al. (2009) show that it is possible to determine the value of projected REDD credits with rigorous methodologies and spatial modeling, by assessing the carbon stock, valuing the opportunity cost of forest conservation in Borneo –namely palm oil plantations–, and estimating the possible benefits from payments for avoided deforestation and carbon sequestration. While the calculation of carbon stocks has become more precise and sophisticated, the uncertainty of whether and how exactly REDD policies would be implemented has a huge influence on the magnitude of the future financial benefits from REDD. So far the analyses have focused on estimating the impact of different carbon prices. Nevertheless, many other factors are uncertain and thus should be considered variable in the scenarios, such as the requirements of additionality, leakage and permanence, the costs of REDD policies, among others.

Benefits of biodiversity conservation

The valuation of the benefits of biodiversity conservation still struggles with defining the universe of valuation. The economic value in biodiversity is very much subject to the demand to see it (tourism), protect it (by governments and the international community) or consume it (bushmeat, wildlife trade, bioprospecting). However, the magnitude of the demand varies substantially depending on who is being considered (local tourists vs. international tourists), the type of forests and numbers of species present, the presence of iconic species such as the orangutan, and the perceived and real threats to the ecosystem and species (demand for conservation should increase as the risk increases). Also, biodiversity relates to the supply of other ecosystem services, for instance nutrient cycling and productivity of NTFP; although understanding how is challenging.

Biodiversity varies significantly throughout the landscape, so it is very appropriate for studies to incorporate spatial modeling into the valuation as Wilson et al. (in press), Naidoo & Adamowicz (2005) and Naidoo & Ricketts (2006) did. Spatial modeling also allows the modeling of habitat degradation and fragmentation, which translates into loss of biodiversity value.

Although spatial modeling gives a clearer picture of biodiversity values, absence of data may lead to undervaluing of the economic value of biodiversity. This is very likely in Borneo, particularly for wildlife trade. Although illegal, this is an important economic dimension of biodiversity and represents both a benefit for smugglers and a cost for Malaysia and Indonesia. The literature reviewed does not mention wildlife trade in their valuation, but its value could possibly be estimated in aggregate as it is done with illegal logging.

Value transfers

The economic valuation of biodiversity benefits shows the perils of taking the monetary values out of context and deriving the wrong conclusions from the valuation. Chiabai et al. (2009) generated value transfer functions of forest ecosystem services to be able to make cross-country comparisons. These functions were modeled using estimated values for forest services from valuation studies, so that a relationship was derived between these values and the size of forest areas, income level and population density. Interestingly, the results showed that forests in the "Other Asia" region –as classified by the study– where Borneo belongs, had a lesser marginal economic value than forests in North America. The reason for this result is that income levels are lower in Asia so willingness to pay for forest ecosystem services is lower, not that necessarily forest services are inferior. Knowing the incredible biodiversity of Borneo, these transfer protocols are problematic with biodiversity and tourism, as the willingness to pay for biodiversity in many tropical countries is more a function of foreign tourists' income than of the income of local residents. Hence, it is important not to derive the wrong conclusions from the fact that the economic value of some tropical forests is less than some temperate ones.

Also, it is important to realize that although economic value is tied to the extent of forest, it is also tied to demand-supply curve for these services. If there is willingness to pay, for instance, for hardwood timber, the overall economic value of forests may increase even as the forest is getting smaller, if the prices of wood are getting higher by a larger margin. It is important to discern these effects when making comparisons of the economic value of ecosystem services across time, as they do not necessarily follow the trends of provision of the service.

This cautionary example of deriving the wrong conclusions from economic value estimates serves to illustrate the importance of knowing very well how to transfer values from other studies. Although many studies that were reviewed for this literature review provide estimates of NPV and BCR for different land uses, none of them are directly comparable since the assumptions and parameters utilized were different. Hence, there is no comparative table of results as it may induce false comparisons from the reader's perspective. It is therefore very important to go back to each individual article to understand how the results from different studies can be compared and what adjustments to the data are necessary to do so.

Costs of biodiversity conservation

Biodiversity conservation as a land use incurs costs in addition to opportunity costs. Naidoo & Adamowicz (2005) showed that given the appropriate conditions for tourism, some biodiversity markets could be developed for foreign visitors to pay entrance fees to protected areas, pay the costs of conservation and distribute benefits to local people. Venter et al. (2009), Wilson et al. (in press) and Naidoo & Adamowicz (2005) showed that with the appropriate data, differentiation of the costs and benefits of conservation is possible comparing sites with different number of species. These methodologies could certainly be used in Borneo for specific well renowned tourist sites, and for potential ones as well, to determine the potential for biodiversity markets from tourists' willingness to pay, especially for areas with iconic species like the orangutan and the proboscis monkey.

Wilson et al. (in press) give the great insight that if protected areas (PAs) are considered the sole valid conservation strategy, the costs of conservation are overestimated, as no conservation value is assigned to the areas outside of protected areas. Although of lesser value, some conservation objectives are fulfilled with production areas with sustainable practices, such as production forests with reduced impact logging, so the costs of conservation are effectively spread out across various land uses. In their study, the use of coefficients of importance of each land use for each mammal species is innovative and could be replicated for other taxa.

Opportunity costs as a measure of forest conservation

The study by Wilson et al. (in press) raises the question of whether the opportunity costs of preserving forests are an appropriate estimate of the actual costs of forest conservation, be it for REDD or biodiversity. The reasoning behind using opportunity costs is that setting aside protected areas and/or preventing deforestation implies foregoing income from timber and agriculture, and so the cost to society is valued by that foregone income. For Wilson et al. (in press), however, this assumption overestimates the costs of conservation from a financial analysis perspective. Although in economic valuation the use of opportunity costs falls in line with theory, when in reality areas are set aside for conservation, the financial costs of conservation rarely have to compensate for the entire range of opportunity costs, although they do have to deter activities with higher opportunity costs such as poaching and illegal logging.

Despite the assumption that REDD must match the opportunity costs of palm oil, as van Beukering et al. (2008) points out, this requirement is not categorical. Deforestation not only occurs as a rational response to profitable opportunities but is also facilitated by weak governance, lack of law enforcement, bad zoning policies and other policies that favor deforestation. The opportunity costs are not a measure of the highest possible profit that could be earned from that land regardless of the law, but within the law. Hence, opportunity costs can be lowered through policy levers like zoning, taxation and law enforcement. If these policy levers are put in place, REDD benefits do not need to add up to the opportunity costs of palm oil and can be less. Venter et al. (2009) suggested that REDD can work by compensating opportunity costs by 50%.

To explain this argument further, the studies by Naidoo & Adamowicz (2005) and Naidoo & Ricketts (2006) are illustrative. In them, protected areas that are already established have zero opportunity costs because they cannot legally be converted, so there is no legal possibility of earning income from agriculture or logging. By assigning a value of zero to these areas, the authors admit to the power of the law in dramatically reducing opportunity costs. If the law has the power to change the opportunity costs drastically, their use as a proxy for conservation costs is misleading. Changing the law to designate more protected areas may not be as costly for a government than compensating the full value of the opportunity costs – which means compensating for the value of the land and expected future profits. To the extent the government may compensate for the designation of new protected areas, it does so by purchasing the land, so land values may be a more sound component of the costs of conservation, embodying part but not all of the opportunity cost. In the Indonesian context, where land prices are not readily available as forest land is government owned, a metric that could be used may be the willingness to pay for forest concessions.

Nevertheless, valuing the opportunity costs of protected areas at zero is an exaggeration, because many protected areas are exploited illegally anyway, for bushmeat, wildlife trade, logging and encroachment, reflecting some opportunity costs. Moreover, the government has powers to degazette or excise parts of protected areas, as is planned in Kutai National Park (Limberg, 2008). Therefore, it seems prudent to model the costs of conservation not only as a function of opportunity costs, but also as a function of law enforcement and the management costs of running protected areas. The study by Wilson et al. (In press) for Kalimantan provides an excellent baseline to estimate the costs of conservation for the Heart of Borneo.

Law enforcement cost and fire management costs are important to consider as additional costs of forest conservation in Borneo. These include the costs of deterring unlawful land uses in protected areas, preventing and suppressing fires and prosecuting offenders. These costs will be higher where there is more pressure for the resources so they will not be uniform across the landscape.

D. TOTAL ECONOMIC VALUATION OR RAPID ECONOMIC VALUATION

Total Economic Value studies are useful to document the overall costs and benefits of a land use or an ecosystem service. However, they are data intensive and time consuming. TEV studies are based on the perspective of society as a whole, whether it is Indonesia as a country (Maturana, 2005) or the Aceh province

(Van Beukering et al., 2008). However, these boundaries are arbitrary because the benefits and costs of many activities extend beyond these borders. Thus, even when they attempt full comprehensiveness, TEV studies cannot claim to evaluate the absolute total economic value. They also cannot realistically evaluate all ecosystem services, so they usually underestimate their full value and may ignore intrinsic values.

In addition, by limiting the evaluation of impacts to only first order effects, TEV studies may be ignoring some important cascade effects of a land use. However, examining the entire set of second order effects may not be the solution, as the valuation would become rapidly unmanageable. For example, Naidoo et al. (2009), valued some second order effects of palm oil production. One was the productivity cost of lost working days as a result of health problems from an increased incidence of fire due to palm oil crops. Another was the savings in greenhouse gas emisons derived from the conversion of palm oil into biodiesel, in substitution of fossil fuels. Although the valuation of these effects is relevant, carrying that same logic to a TEV analysis would make it necessary to also analyze the impact on consumer welfare worldwide of the availability of palm oil products, and perhaps the emissions difference entailed from substituting other vegetable oils for palm oil. This would easily become an impossible task, so it is important to delineate limits to first order or second order effects, and yet this unfortunately blurs the concept of Total Economic Value.

In addition, TEV studies have the limitation that they are not very practical for policymakers in the short term as they don't indicate the marginal impacts of land use decisions. Chiabai et al. (2009) argue that the concept of Total Economic Value is not very useful, as it is more important to know the economic losses from deforestation of an additional hectare. TEV studies tend to be more useful for advocacy than for addressing specific policy problems or solutions.

The Participatory Rapid Economic Valuation (PREV) (Cannon & Surjadi, 2004) demonstrates that a valuation of all services is not necessary to guide policy decisions. They showed that the logging concession in the Togean Islands should be rejected, simply because the costs on fisheries and tourism exceeded the overall benefits from logging. Thus, there was no need to value the impacts of logging on additional services. Naidoo et al. (2009) reached the same conclusion with their rapid economic valuation of palm oil and forest carbon in Borneo. Rapid Economic Valuation does not have to be participatory though. Although its participatory nature gives PREV high legitimacy, relevance and credibility, a cordial participation of policymakers may not always be possible, particularly if they have vested interests in the land use decision to be made.

E. DISTRIBUTIONAL ANALYSES OF ECONOMIC VALUATION

Gouyon and Simorangkir (2002) point out the need for an economic impact analysis fom the perspective of various stakeholders, which may expose the stark differences in cost and benefits for plantation companies, provincial and central governments, smallholders and the global community. A distributional analysis would look at the same land use from these different perspectives, clearly showing winners and losers and therefore being useful to design policies to reconcile the interests of different stakeholders.

Focusing on distributional analyses, which have been limited so far, can be an excellent contribution for economic valuation in the Heart of Borneo. Naidoo et al. (2009) showed an example of how this can be done, when they categorized plantation labor as a local benefit (for workers) but as a cost from the perspective of companies. Similarly, Belcher et al. (2004) showed an important difference in perspective of the financial returns to palm oil from the perspective of small farmers. Small farmers in East Kalimantan have not converted completely to palm oil and still maintain rattan gardens. Palm oil is more profitable indeed, but rattan has lower risks for farmers as it can be harvested anytime, allows for interplanting with other crops, demands less labor and is highly prized by local tradition. Traditional financial indicators do not capture these insights, so even the choice of indicators can affect the distributional analysis. Although palm oil had a much higher IRR and NPV than rattan, it had lower returns to labor than rattan, which the authors argued was a more important indicator for farmers.

Distributional analyses extend to the government. The study by Human Rights Watch (2009) presented powerful data documenting the immense costs of illegal logging to the government of Indonesia due to uncollected taxes. The analysis of costs and benefits to the government could also include palm oil, timber plantations and coal mining.

Depending on the situation and data availability, in some instances a spatial distribution analysis may be more relevant. Van Beukering et al. (2008) gave their results of economic valuation distributed by district within Aceh.

F. ECONOMIC VALUATION AND POLICY SCENARIOS

WWF wants to promote conservation policies. Thus, it would be very appropriate for WWF's economic valuation of ecosystem services and land uses in Borneo to show the potential impacts of various policy scenarios. For example, WWF could model the costs and benefits for the government of designating new protected areas, subsidizing Reduced Impact Logging, increasing taxes on palm oil and timber or increasing investments in law enforcement and fire management. For instance, Fatah (2008) used various policy scenarios of taxation and regulation of coal mining to evaluate economic and environmental outcomes.

These policy scenario studies could be linked with solution-oriented questions. For example, WWF could ask the question: What are the appropriate levels of subsidy or reduced taxation that can bring Reduced Impact Logging at similar profitability to conventional logging in Borneo? Answering this question would require spatial modeling to estimate operational costs of RIL in different areas of Borneo, depending on terrain, soil qualities, accessibility and forest characteristics. The analysis would investigate the subsidy or taxation levels at which RIL becomes financially attractive in the short term and not just in the long term. This is relevant as many logging operations do not look forward many decades and on the contrary set out to harvest higher quantitites in the first harvest for immediate benefit.

Policy scenarios for REDD

Policy modeling is very important for REDD. The literature reviewed reflects the technical progress in calculating forest carbon stocks in tropical forests. However, the financial assessments of REDD payments are very sensitive to various policy assumptions, such as the inclusion/exclusion of peat areas, the rigidity of the additionality requirements, the use of planned deforestation to determine baseline deforestation rates, the methods for absorbing permanence risk and the interchangeability of REDD credits with other carbon credits.

These are among the unresolved policy questions of implementation at the national and international levels which may alter significantly the financial and economic valuation of REDD.

Furthermore, there is a gap in knowledge of the cost of implementation of REDD policies at the national level in Indonesia and Malaysia, which is an area where further studies would be very useful. Van Beukering et al. (2008) employed indicative transaction costs of REDD in the Ulu Masen project in Aceh, one of the first REDD projects in Indonesia, but these costs are likely to vary significantly depending on the locations and on the policy actions involved. Policy options for REDD implementation range from direct payments to landowners or concessionaires, as a form of PES (Grieg-Gran, 2008), to sectoral policies like increase in fire management capacity, enhancement of law enforcement to prevent deforestation, land titling, alternative livelihood programs for farmers, subsidies for plantations to cultivate degraded land, among others. If REDD+ passes, the additional sustainability and social criteria may increase REDD operational costs but at the same time increase the overall economic value of REDD projects. In addition, costs need to include the expenses of monitoring deforestation. At the distributional level, it is desirable to evaluate how different scenarios would benefit forest inhabitants, provincial and state governments, central governments and concessionaires. This should be possible soon for Indonesia with the new rules for revenue sharing for REDD projects that the government issued in 2009, although the regulation is currently in dispute because it was issued by the Ministry of Forestry, while it is the Mininstry of Finance the one responsible to deal with revenue sharing

All this variability in REDD policy assumptions and uncertainty in costs entails significant variability for prospective REDD payments in Borneo. For this reason, REDD studies that research the financial outcomes of multiple policy scenarios would be very illustrative, even if many of these scenarios have to sacrifice some precision in order to examine a wider range of alternatives.

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ANNEX: MATRIX OF LITERATURE OF FINANCIAL AND ECONOMIC ASSESSMENT OF THE HEART OF BORNEO (Excel file)

GLOSSARY OF KEY TERMS

Literature review: Methodologies for financial and economic assessment of forest ecosystem services and land uses that cause deforestation in Borneo

Iván Darío Valencia

WWF

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Benefit Cost Ratio

This ratio expresses the benefit gained per unit of costs invested. It is calculated by dividing the total economic benefits of an activity by the total economic costs. Where economic benefits are greater than costs, the benefit–cost ratio is greater than 1—that is, the activity is economically feasible. Where economic benefits are lower than costs, the ratio is less than 1.

Benefit Transfer –Value transfer

The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.

Source: http://www.ecosystemvaluation.org/benefit_transfer.htm

Cost-benefit analysis

Benefit–cost analysis involves comparing an activity's total value of costs with the total value of the benefits generated. Costs and benefits include both the monetary values to the person conducting the activity, externality costs and benefits, and nonmarket/ non-monetary benefits and costs.

Discount rate

The discount rate is the rate at which society as a whole is willing to trade off present for future benefits. The discount rate plays an extremely important role in determining the outcome of the analysis. The net present value, benefit-cost ratio, internal rate of return, among other indicators, depend critically on the chosen discount rate. Discount rates are used to compress a stream of future benefits and costs into a single present value amount. Another way of thinking about discount rates is as the inverse of compound interest. That is, whereas compounding measures how much present-day investments will be worth in the future, discounting measures how much future benefits are worth today.

Source: www.csc.noaa.gov/coastal/economics/index.htm.

Distributional analysis

Financial or economic analysis of the same economic activity from the perspective of different stakeholders. For example, a palm oil plantation can be analyzed financially from the perspective of i) the company, ii) the government, iii) workers, among others.

Economic analysis

Focuses on the interests of society as a whole. That is, it assesses from a national perspective whether an activity will increase social wellbeing. Compared to financial analysis, which addresses the monetary (commercial) feasibility of activities, economic analysis also considers the nonmonetary, nonmarket benefits and costs of an activity, along with that activity's economic, environmental and social impact on people not directly involved with the project.

Financial analysis

Focuses on the financial interests of individuals, families and/or the community directly involved in a project. It addresses the question of whether an activity is commercially practical and financially profitable. Financial viability is crucial for all projects because each project has only limited resources from which to fund activities and achieve outcomes. Most people understand the general need for a financial analysis to determine how much an activity will cost and, where commercial activity is concerned, how much revenue it will generate.

Internal Rate of Return

The internal rate of return on an investment or potential investment is the annualized effective compounded return rate that can be earned on the invested capital. Because the internal rate of return is a rate quantity, it is an indicator of the efficiency, quality, or yield of an investment. This is in contrast with the net present value, which is an indicator of the value or magnitude of an investment

Source: Wikipedia

Net Present Value (NPV)

NPV is a primary investment decision criterion. NPV is defined as the difference between the present value of a stream of benefits and that of a stream of costs. A positive NPV occurs when the sum of the discounted benefits exceeds the sum of the discounted costs. A negative NPV is usually called a Net Present Cost (NPC). The decision rule is to select the option that offers to maximize NPV, or minimize NPC. This is subject to assessment of those impacts that cannot be valued in money terms. NPV takes account not only of social time preference through discounting, but also, by combining capital and recurrent cost and benefits into a single present day value indicator, enables direct comparison of options with very different patterns of costs and benefits over time.

Source: http://www.dfpni.gov.uk/eag-glossary

Opportunity costs

The value of the use of resources in an alternative way that is not obtained when the resources are used in the current way.
Source: www.economics.noaa.gov/

Returns to labor

The output generated per each additional unit of labor

Sensitivity analysis

A sensitivity analysis measures the impact on the expected outcome of an analysis of changing the value of one or more important, uncertain variables. The value of a sensitivity analysis is to consider the optimistic, expected, and pessimistic scenarios for a project, with *reasonable* values substituted for the uncertain ones.

Source: www.csc.noaa.gov/coastal/economics/index.htm

Shadow price

The opportunity cost to society of participating in some form of economic activity. It is applied in circumstances where actual prices cannot be charged, or where prices do not reflect the true scarcity value of a good.

Source: http://www.dfpni.gov.uk/eag-glossary

Total Economic Value

Total value consists of two main elements: use value and nonuse value. Use value captures indirect use in addition to direct use as described previously. Indirect use is related to special functions of some ecosystems. For example, lakes, oceans, and rivers assimilate waste, and provide habitats for wildlife; forests act as carbon sinks, prevent soil erosion and encourage soil production; wetlands offer flood control and trap nutrients and sediments.

Source: Encyclopedia of Earth

Value added

In economics, the difference between the sale price of a product and the cost of materials to produce it is the value added.

Source: Wikipedia

Willingness to pay

The amount that someone is willing to give up or pay to acquire a good or service.
Source: www.dfpni.gov.uk/eag-glossary