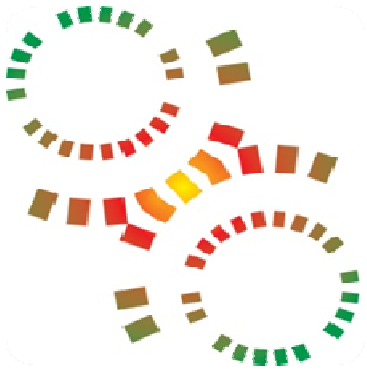

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Stakeholders' incentives for land-use change and REDD: The case of Indonesia

Silvia Irawan

Crawford School of Economics and Government
The Australian National University

Luca Tacconi

Crawford School of Economics and Government
The Australian National University

Irene Ring
UFZ – Helmholtz Centre for Environmental Research, Leipzig

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luca.tacconi@anu.edu.au

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Stakeholders' incentives for land-use change and REDD: The case of Indonesia

Abstract

The opportunity costs of Reducing Emissions from Deforestation and Forest Degradation (REDD+) accruing to different stakeholders in Indonesia, including companies and the national, provincial and district level governments, are estimated, with particular emphasis on the influence of alternative discount rates. A cost–benefit analysis of the opportunity costs of avoided deforestation is conducted. The three major land-use activities considered are commercial logging, timber and oil palm plantation. The opportunity cost of oil palm plantations on mineral soil preceded by logging of degraded forest is prohibitively high. REDD+ measures that impose restrictions on the development of those land-use activities would lead to a substantial loss of public revenues at the various government levels. The design of a national REDD+ scheme needs, therefore, to take into account the opportunity costs faced by subnational governments. To influence their behaviour towards land-use change, REDD+ schemes need to create a direct link between the distribution of public revenues and district governments' decisions on land-use activities in their localities.

Keywords: REDD+**,** Deforestation, Opportunity Costs, Discount rates, Decentralisation, Indonesia

Introduction

The agreement on Reducing Emissions from Deforestation and Forest

Degradation (REDD+) reached at the 2010 Cancun meeting of the UN Framework Convention on Climate Change (UNFCCC) is expected to result in a significant flow of funds from developed to developing countries. Research on the economics of REDD+ has focused, therefore, on estimating the costs of REDD+ and the required flow of funds at the global, national, and sectoral levels (for example, Bellassen and Gitz, 2008; Boucher, 2008; Butler et al., 2009; Grieg-Gran, 2008; Kindermann et al., 2008; Pagiola and Bosquet, 2008; Wertz-Kanounnikoff, 2008). Depending on the methods used, global reviews of the opportunity costs of REDD+ estimate them to lie between US$2.51/tCO$_2$ (Boucher, 2008) and a range of US$10 to 21/tCO$_2$ (Kindermann et al., 2008). These studies of opportunity costs have focused on private stakeholders – namely, companies and smallholders. However, the legal framework determining the rights over forests needs to be considered in estimating the opportunity costs of REDD+ and the associated incentives at the national level. The legal framework regulates who owns forests, who bears the costs of the implementation of REDD+ activities and, therefore, who should receive appropriate incentives to change deforestation-related behaviour (Gregersen et al., 2010). When the state claims ownership of forests – a situation common in many of the top deforesting countries (Tacconi et al., 2010) – the opportunity cost it faces in reducing emissions from forests is equal to the revenue stream it forgoes for not issuing permits for income-generating activities in forests (Gregersen et al., 2010). The costs and incentives faced by governments in the implementation of REDD+ should also be considered, including local level governments – as most countries responsible for emissions from deforestation and forest degradation have implemented some degree of decentralisation in public administration and forest management (Irawan and Tacconi, 2009), but

these costs and incentives have not yet been addressed.

Local governments often obtain (a share of) revenues from timber extraction and agricultural development. It is in the interest of local governments and their citizens, to whom they are accountable in a democratic country, to maximise the revenues from resource utilisation (Tacconi, 2007).[1] As REDD+ policies and measures might restrict local governments' capacity to generate those revenues, compensation to reconcile local costs with the benefits that reach far beyond local boundaries may be required for local governments to support the implementation of REDD+.

This paper assesses the implications for forest management and REDD+ of the distribution of benefits from deforestation and forest degradation across the private sector and the various government levels. To do this, the paper estimates the opportunity costs of REDD+ accruing to the national, provincial and district[2] governments and companies in the provinces of Riau and Papua, Indonesia – an important case study in its own right because it is the largest global emitter of greenhouse gases from the forestry sector if emissions from peatlands are included (Houghton, 2003). The estimation of government's opportunity costs is based on taxes, fees and charges generated by the alternative land-use activities, taking into account the implications of adopting alternative discount rates, an issue that has not been clearly addressed by previous studies focused on REDD+.

The paper first presents the forest governance framework in Indonesia which

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[1] This does not imply that revenue maximisation is, or should be, the only parameter used by local governments to make decisions concerning the exploitations of natural resources. There is evidence, however, that it is a significant determinant of forest resources management (exploitation). For example, see Barr et al. (2006) and Andersson et al. (2006).

[2] The third tier of government in Indonesia includes districts and municipalities, the latter referring to city areas. We refer only to districts, as forests are not found in municipalities. Moreover, 'subnational' and 'local' levels are used interchangeably to refer to both provincial and district levels.

affects the distribution of incentives from forests and land-use change and REDD+. The methods used are discussed before presenting the results of the estimation of opportunity costs and their distribution. This is followed by a discussion of the implications for REDD+ and the conclusion.

2. Forest governance, deforestation, and public revenues in Indonesia

2.1. Governance, deforestation and forest degradation

The Forestry Law 41/1999 grants the national Ministry of Forestry the authority to manage 120 million hectares of state forest land. According to the Law, forested lands are classified into production, protection, and conservation forests. The main function of production forests is to produce forest commodities, mainly timber. Some production forests are also classified as conversion forests, which can be legally converted to other non-forest land-use activities. Protection forests provide environmental services such as hydrological regulation, flood prevention, erosion control, avoidance of seawater intrusion and maintenance of soil fertility. Conservation forests, which include national parks and nature reserves, are intended to conserve biodiversity.

A number of productive activities are permitted by law to exploit Indonesia's forests and often cause forest degradation and deforestation. Commercial logging is normally the first activity allowed to open up natural forests legally. This activity requires the issuance of a commercial logging concession, which is granted for a 20-year period to perform selective timber-cutting based on legal guidelines provided by the Ministry of Forestry (Kartodihardjo and Supriono, 2000). Over the past 40 years, commercial logging operators have failed to implement sustainable forest management (Kartodihardjo and Supriono, 2000). According to 1998 data, 16.57 million hectares out of 69.4 million hectares under

logging concessions were degraded (Kartodihardjo and Supriono, 2000). Forest degradation data for 2004 show that this trend continued into the first part of the 2000s (Nawir et al., 2007). The total area of degraded production forest amounts to 14.2 million hectares, with an additional 13.6 million hectares of logged-over areas. The area of degraded forest inside the protection forest category in 2004 was reported at 8.1 million hectares (Nawir et al., 2007).[3]

Despite the severe destruction of natural forests caused by logging operators, the government continued to issue logging permits in natural forests to generate revenues and employment (Kartodihardjo and Supriono, 2000). Licences granted to logging operators that caused severe forest degradation at the end of the concession period were terminated in some cases, and the degraded forest handed over to a state-owned company for rehabilitation (Kartodihardjo and Supriono, 2000; Nawir et al., 2007). However, one of the so-called rehabilitation policies actually involves converting severely degraded forest to commercial timber plantations. The underlying concept was to replace forest vegetation (with a remaining standing stock of less than 16 m^3 per hectare) with fast-growing species such as acacia (Kartodihardjo and Supriono, 2000; Nawir et al., 2007),[4] thus legitimizing forest degradation within commercial logging areas (Kartodihardjo and Supriono, 2000).

According to the Forestry Law, conversion forests can be allocated to a number of purposes, including infrastructure and other land uses such as agriculture, tree crop plantations and mining. Conversion forests are not supposed to have

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[3] Forest degradation is defined as forested lands that are severely impacted by intensive and/or repeated disturbances, therefore, the abilities of forests to supply goods and services are reduced (Nawir et al., 2007).

[4] The precise definition of unproductive forests, however, varies. Since 1986, large-scale timber plantations must be allocated on unproductive forests, ranging from 5 to 20 m^3 commercial timber per hectare (Pirard, 2008).

significant tree cover or timber potential. In reality, however, primary forests can also be found in areas designated as conversion forests. In Papua, approximately 3.6 million hectares of conversion forest are primary forest (Ministry of Forestry, 2008b). One of the major drivers of the massive conversion of Indonesia's natural forest is the establishment of oil palm plantations (Butler et al., 2009; Koh and Wilcove, 2008; Sandker et al., 2007; Venter et al., 2009). Conversion of natural forests to oil palm plantations provides additional profits for plantation companies because timber is harvested and sold during land-clearing at the beginning of operations. As a result, companies seek to acquire areas larger than the area which will actually be planted (Forest Watch Indonesia and Global Forest Watch, 2002; Kartodihardjo and Supriono, 2000).

2.2. Public revenues from forest and land use change

The aforementioned land-use activities generate revenues for all levels of government. Before discussing the methods and the revenues generated by each activity, let us consider the existing decentralised forest governance arrangements, including rules on the distribution of public revenues.

District governments (elected by citizens) have the authority to provide important public services, while provincial governments represent the national government. The authority to issue commercial logging permits in production forests is still held by the national government. Provincial governments approve annual logging plans prepared by concessionaires, while district governments provide technical recommendations to the national government related to logging operations within their administrative boundaries. Commercial logging extraction is considered the most lucrative activity in the forestry sector (Barr et al., 2006). Public revenues collected by the national government from commercial logging comes from licence fees, forest rents, the reforestation fund, the land and

building tax, and personal and corporation income taxes.

All public revenues generated from commercial logging extraction, except the corporation tax (which is retained by the national government), are distributed amongst government levels using a revenue-sharing mechanism. A licence fee is paid when a timber concession is issued or renewed. The amount of fees charged depends on the size of the concession area and whether it is a new licence or a renewal. The forest rent is a timber royalty, which is collected on the basis of volume and the type of species harvested. The reforestation fee is non-refundable and is based on the type of species, grade and location of the wood harvested. Revenues are allocated across governmental levels according to percentages established in Law 33/2004 and Government Regulation 55/2005 (see Table 1).

District governments are authorized by Law 26/2007 on Spatial Planning to develop local spatial plans according to guidelines and norms established by the national government. Of particular significance to the research presented in this paper, district governments can submit proposals for land-use change within conversion forests to the Ministry of Forestry. If forests are converted to crop plantation activities, government at all levels also obtains revenues from other taxes and charges. Charges applied to plantation activities are the land and building transfer fee, as well as taxes on land and buildings, personal and corporate incomes, and the market value added to plantation products. The national government retains the totality of the value added tax from plantation products and the corporate income tax. As with taxes on logging activities, the land and building tax and the fees from plantation activities are distributed back to districts and provinces using the revenue-sharing scheme, thereby sustaining the activities within their administrative boundaries. Government regulation

48/1997 stipulates that the tax on plantations of 25 hectares or more could be up to 40 per cent of the selling value of the land. Other revenue sources for district governments related to plantation activities are the fees they charge on agricultural products. The form and amount of local fees on oil palm products varies between localities.

Table 1. Percentage allocation of taxes and natural resource fees between government levels

Revenue Source	National	Provincial	Originating District	Other Districts in the Same Province	All Districts in Indonesia
Land and Building Tax	9	16.2	64.8	0	10
Land and Building Transfer Fee	0	16	64	0	20
Personal Income Tax	80	8	12	0	0
Forest Licence Fee	20	16	64	0	0
Forest Resource Rent	20	16	32	32	0
Reforestation Levy (funds)	60	0	40	0	0

Source: Law 33/2004 on Fiscal Balance between the Central and Local Governments; Government Regulation 55/2005.

3. Methods

3.1. Opportunity cost analysis

The cost of implementing REDD+ includes opportunity costs, management costs and transaction costs. Opportunity costs are the benefits of the best alternative land use that are forgone as a result of reducing deforestation and forest degradation (Grieg-Gran, 2008; Pagiola and Bosquet, 2008; Wertz-Kanounnikoff, 2008). Management costs arise from activities such as illegal logging prevention, research for agricultural intensification and land titling to provide traditional and

indigenous communities with incentives to safeguard forests (Nepstad et al., 2009; Pagiola and Bosquet, 2008; Wertz-Kanounnikoff, 2008). Transaction costs relate to the processes to identify and negotiate REDD+ activities as well as to perform monitoring, reporting, verifying and certification of carbon emission reductions (Cacho et al., 2005; Milne, 1999). This paper focuses on the opportunity costs, as they are thought to account for the largest share of the costs (Pagiola and Bosquet, 2008). It should be noted, however, that the other costs could be more than insignificant. The transaction costs reported in the literature are in the range of US$0.01–16.40 per tCO_2 (Wertz-Kanounnikoff, 2008), while the management costs, in the Brazilian Amazon for instance, were estimated at US$1–3 per hectare per year (Nepstad et al., 2009).

Approaches that are commonly used to estimate the opportunity costs of REDD+ include local as well as global empirical models and global simulation models (Wertz-Kanounnikoff, 2008). Local empirical models use data collected directly within a particular location, mostly through surveys. Based on the amount of carbon that would be lost should deforestation take place, the benefits from the next best alternative land uses ($/ha) are then converted to the value of per-tonne carbon dioxide equivalent ($/$tCO_2$eq). The estimates from local empirical models can be further aggregated to obtain global per-area opportunity costs, which usually ignore the variation of carbon density across space (Wertz-Kanounnikoff, 2008). Global simulation models estimate opportunity costs using dynamic models of the world economy. Those models include important sectors that affect land use such as forestry, agriculture and energy (Kindermann et al., 2008; Wertz-Kanounnikoff, 2008). As this study assesses the opportunity costs faced by different national stakeholders, it uses the local empirical approach. Different land users face different costs and benefits in reducing emissions, and

the cost of pursuing REDD+ can be described by a supply curve (Boucher, 2008). We will consider, therefore, the different land uses separately in order to identify their relative costs and benefits (and their distribution to the stakeholders) to assess whether they could be prioritized for cost-effective emission reductions. It is important to emphasise that even when the same method is applied (for example, the local empirical method), the estimates of REDD+ opportunity costs – even those in the same country –can vary as a result of different data sources and, importantly, the discount rate used. For instance, the opportunity cost of oil palm in Indonesia has been estimated at US$9.85–33.44 per tCO_2 on mineral soil and US$1.63–4.66 per tCO_2 on peat soil by Venter et al. (2009), and US$7.66–19.24 per tCO_2 (without reference to soil types) by Butler et al. (2009).[5] The differences in estimates appear to be due to the sources of data and the assumptions used as follows.

- Profit data for oil palm plantations: Butler et al. (2009) assessed the profitability of a hypothetical oil palm plantation by calculating year-by-year yields and applying alternative pricing scenarios, whereas Venter et al. (2009) used profit data from published materials of several companies operating in Indonesia. The profit data used by Venter et al. (2009) were the net profits (after taxes) of companies operating in Indonesia. Butler et al. (2009) did not consider government taxes in their estimation of companies' net profits.
- Prices of palm oil: Butler et al. (2009) used price data and forecasts through to 2020 from The World Bank. They assumed that, under a high-price scenario, the price was constant at 749 US$ton from 2009 to 2039.

[5] Butler et al. (2009) report REDD opportunity costs from oil palm plantations are US$3,835–9,630 per hectare, while the net carbon saving of avoided conversion is 149 tons/ha.

Under a low-price scenario, they used the price of 643 USD/ton in 2010, which decreases to US$ 510 in 2020 and remains at that level until 2039. Venter et al. (2009) did not state the price of palm oil used, as they use the net profit data from companies' reports.

- Carbon stock data: Butler et al. (2009) used an average amount of avoided emissions of 682.92 tCO_2/ha, while Venter et al. (2009) spatially estimated the avoided emissions in mineral and peat soil forests at 389 tCO_2/ha and 2,249 tCO_2/ha respectively.
- Discount rates: Butler et al. (2009) used a 10 per cent discount rate, whilst Venter et al. (2009) applied an 8 per cent discount rate.

3.2. Discount Rate

According to Smith (2011), the choice of the discount rate depends on whether: i) the policy question is marginal or non-marginal; ii) social or private preferences should be considered; and iii) the country is developed or developing (that is, the relative level of income). A policy aimed at implementing REDD+ over large areas for a long period of time is a non-marginal policy. Non-marginal policies are evaluated using a social discount rate, rather than a market rate which reflects private preferences (Smith, 2011). Social discount rates are lower than private ones because, *inter alia*, social preferences place greater value on the welfare of future generations compared with private preferences. In relation to the development stage of a country, the Garnaut Review (2011) suggests that discount rates applied in developing countries should be higher than those in developed countries. This is due to the fact that the present generation in developing countries can be expected to be significantly poorer than future ones, whereas the gap in welfare between generations is more limited in developed countries.

The social discount rates used by major assessments of climate change policies, such as the Stern Review and the Garnaut Review, were as low as 1 to 2 per cent (Smith, 2010). However, the most common rate used by studies of the opportunity costs of REDD+ has been 10 per cent (Grieg-Gran, 2008). To account for the gap between the wealth of different generations in a developing country such as Indonesia, we use a social discount rate of 5 per cent, which is significantly higher than that used in the Stern and Garnaut Reviews. A positive rate (determined from observation of market data) could also be considered to approximate social preferences, with the most appropriate one being the yield of long-term government bonds (Smith, 2010). For Indonesia, this rate currently is about 7 per cent.[6]

International practice recommends discount rates varying from 1 to 15 per cent in the assessment of the value of projects (Harrison, 2010). To enable consideration of the different social and business issues that arise in assessing land-use options, we present opportunity costs calculated using discount rates of 5, 10 and 15 per cent with a 30-year time horizon. The rate of 10 per cent is slightly higher than the rate of long-term government bonds, but it presents a useful mid-point between the lower social discount rate and the higher private discount rate.

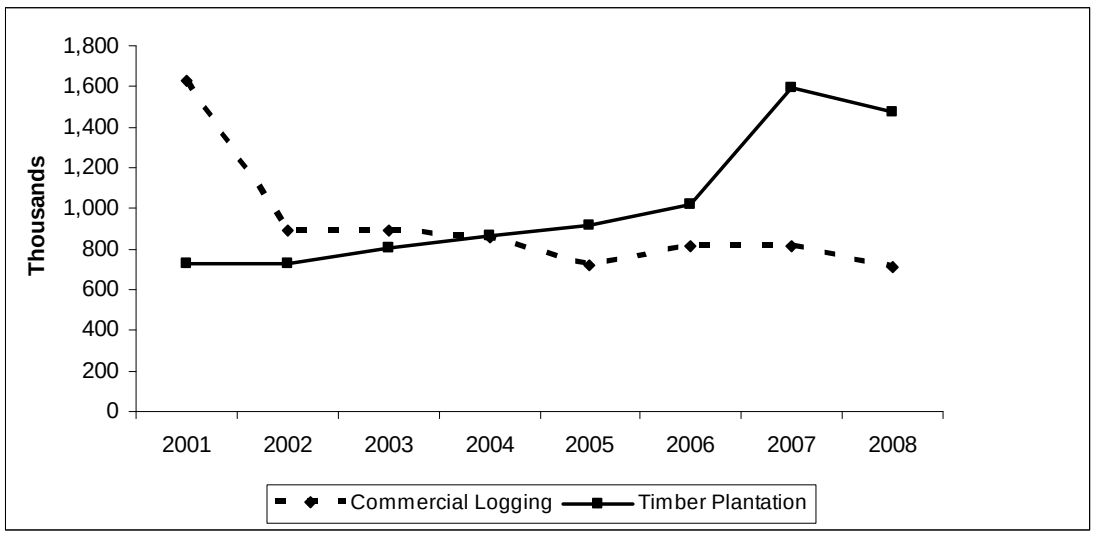
3.3. Case studies: provinces and data on land use activities

This study focuses on the two provinces of Riau and Papua, which vary in terms of deforestation rates and causes of deforestation. Riau is thought to have the highest deforestation rate in Indonesia, with an estimated total forest loss between 1982 and 2007 of around 4.2 million hectares, approximately 65 per

[6] http://www.tradingeconomics.com/Economics/Government-Bond-Yield.aspx?symbol=IDR, accessed on 18 August 2011.

cent of the original forest cover (Uryu et al., 2008). Two major causes of deforestation in Riau are the expansion of oil palm plantations and timber plantations to supply the pulp and paper industry. Between 1982 and 2007, 1.1 million hectares (28.7 per cent) of Riau's forests were replaced by oil palm plantations, while 0.95 million hectares (24.4 per cent) were cleared for acacia plantations (Uryu et al., 2008). Logging concessions within production forests are being replaced by acacia plantations (Figure 1). Uryu et al. (2008) also report that 659,200 hectares (17 per cent) were deforested but have not been planted yet; the remaining lands were cleared for smallholder oil palm plantations (7.2 per cent) and other purposes (18.1 per cent), such as rubber, coconut and other plantations, and infrastructure.

Figure 1. Logging concessions and timber plantations in Riau's production forests



Source: Forest Statistics 2001–2008 issued by the Ministry of Forestry.

The Papuan region (which includes the provinces of Papua and West Papua) is home to the largest area of remaining tropical forest in Indonesia and it has the

lowest rate of deforestation in the country. FWI and GFW (2002) estimate that 1.8 million hectares were deforested between 1985 and 1997, representing 5 per cent of Papua's total forest cover. During 1997–2000, the total forest loss was roughly 2.9 million hectares, but it slowed between 2001 and 2005, with a total forest loss estimated at 0.57 million hectares (Andrianto et al., 2008). Between 2003 and 2006, the annual deforestation in Papua province alone was said to be 19,481 hectares (Ministry of Forestry, 2008a), but this estimate cannot be reliably compared with those mentioned above as they used different methods. Between 2001 and 2005, nearly 1.49 million hectares of production forests in Papua and West Papua provinces were degraded by logging (Andrianto et al., 2008). Specific data related to forest degradation in Papua province alone are, however, lacking.

The opportunity costs of REDD+ are estimated by using data from companies currently operating in Riau and Papua provinces. The analysis focuses on three major land use activities: commercial logging operations, timber plantations and oil palm plantations. First, the net benefits derived by companies from land-use activities are estimated using a Net Present Value (NPV) analysis. Then, the forgone earnings per hectare of land accruing to the governments at all levels, including national, provincial and district governments, are estimated. The opportunity costs for all stakeholders are then converted from $/ha to $/$tCO_2$eq. Due to the paucity of carbon stock data for Riau and Papua provinces, the analysis uses data on the time-averaged carbon stocks of different land-use activities in Indonesia that are currently available in the literature.

Financial data for logging and timber plantations were derived from the working plans of five commercial logging operations in Papua and five timber plantations in Riau. Every company that is granted a licence to operate in state forests for

commercial logging or timber plantation is required to submit a working plan document at the beginning of its operation. The document usually includes the harvesting plan, information on expected timber yields, and a financial analysis. Data on commercial logging activities are derived from companies in Papua because only one active logging company is currently operating in Riau, where the remaining commercial timber stock is limited. Data on timber plantations are from Riau only, due to the lack of information on timber plantation companies operating in Papua. According to Indonesia's regulatory framework, only unproductive forests can be converted to timber plantations (Kartodihardjo and Supriono, 2000; Pirard, 2008). This arrangement therefore forbids timber plantations from legally opening intact primary forests. We recalculate the NPV for all companies using standard financial assumptions – particularly for the discount rate – and the timber prices obtained from the average of timber prices used by all companies.

For oil palm plantations, this study draws on data from Butler et al. (2009) and Rotheli (2007). The model presented by Butler et al. (2009) is recalculated to: i) apply the discount rates discussed above; ii) adjust financial and yield assumptions, including oil extraction and palm kernel ratios and crude palm oil price; iii) estimate public revenues from taxes and fees for national, provincial and district governments based on the existing regulatory framework (Table 2); and iv) carry out sensitivity analysis for changes in the price of palm oil. In June 2011, the price was reported at 800 US$/ton[7] (which is used to derive the results presented in Tables 3 and 4) and it is assumed that it would remain constant for the following 30 years. On the basis of The World Bank's price forecasts, Butler

[7] The Economist Intelligence Unit, http://gfs.eiu.com/Article.aspx?articleType=cfs&articleId=1688295353, accessed on 24 June 2011.

et al. (2009) developed: i) a high-constant price scenario of 749 US$/ton from 2009 to 2039, and ii) a low-variable price scenario with a price starting at 643 US$/ton in 2010 and decreasing to 510 US$/ton by 2020, to then remain at that level until 2039. We report sensitivity analysis by using a low price for palm oil of 680 US$/ton (which is the average of the prices used by four companies in Indonesia in 2010) and a high price of 1,000 US$/ton.

Logging incomes estimated by Butler et al. (2009) are also recalculated to accommodate different conditions of the forest cleared at the beginning of oil palm plantations. Natural forests cleared for oil palm plantation are assumed to have a timber potential of 16 m^3/ha in logged-over forests and 90 m^3/ha in intact primary forests respectively. This assumption is based on the actual timber harvested by a timber plantation during land clearing at the beginning of operations in Riau.

The assessment of opportunity costs accruing to governments is based on taxes and fees collected from each land-use activity (Table 2). As the precise rate of taxes and fees depends on the price of land and products, the average rates used in the working plan documents are used to calculate the opportunity cost faced by government. Personal income and export taxes are excluded in the calculation of the opportunity cost of all land-use scenarios. The exclusion of the personal income tax is due to data paucity related to the amount of labour required for each land-use activity. The export tax is ignored because the analysis focuses on the farm gate value.

Table 2. Tax and fee rates related to logging and plantations

Taxes and fees	Rate
Oil Palm Plantations	
Land and Building Tax	0.5 x 40% x determined value of the land
Value Added Tax	10% x Price of Crude Oil and Kernel Oil x Yield
Corporation Income Tax	25% x Net Profit of Companies
Land and building transfer fee	5% x determined value of the land
Commercial Logging and Timber Plantations	
Reforestation Levy	
- Dipterocarpaceae	USD 16/m^3 (Riau); US$ 13/m^3 (Papua)
- Mixed tropical hardwood	USD 13/m^3 (Riau); US$ 10.5/m^3 (Papua)
- Superior (prime) species	USD 18/m^3 (all regions)
Forest Licence Fee	USD 0.289 x Total Area (Timber Plantation in Sumatra) USD 1.67 x Total Area (Commercial Logging in Papua)
Forest Resource Rent	10% x Volume of timber harvested x Timber Price
- Dipterocarpaceae	USD 7.1 x Volume of timber harvested (Riau) USD 6 x Volume of timber harvested (Papua)
- Mixed tropical hardwood	USD 4 x Volume of timber harvested (Riau) USD 2.94 x Volume of timber harvested (Papua)
- Superior (prime) species	USD 10.05 x Volume (all regions)
- Acacia	USD 0.31 x Volume (all regions)
Land and Building Tax	0.5 x 40% x value of object at the selling point
Corporation Income Tax	30% x Net Profit of Companies

Source: Government Regulation No. 59/1998; Government Regulation No. 74/1998; Government Regulation No. 92/1999; Ministerial Decree No. 859/Kpts-II/1999 3.4.

3.3. Carbon stock data

Carbon stock data reported by Palm et al. (2004; 1999) are used as they are the most comprehensive time-averaged data for all types of land uses in Indonesia. Those authors do not, however, provide information on carbon stocks in peat swamp forest. Venter et al. (2009) provide the estimate of carbon emissions in peat and mineral forests related to forest conversion to oil palm plantation, but not for other land-use activities. In order to provide a comparison of opportunity costs in peat versus mineral forests, sensitivity analysis is conducted using carbon stock data from Venter et al. (2009).

Potential total carbon losses are converted from ton of carbon per hectare (tC/ha)

to metric ton of carbon dioxide equivalent per hectare (tCO_2eq/ha) by multiplying by the molecular weight conversion factor of 3.66 (IPCC, 2006).

4. Results: the opportunity costs of REDD+ and their distribution

Oil palm and timber plantations generate the highest NPVs per hectare for all stakeholders compared to commercial logging (Table 3) which, in the case of oil palm, is some 20 times that of logging. It has already been noted by other studies that logging of primary or degraded forests often generates additional benefits for timber and oil palm plantations (Butler et al., 2009; Fisher et al., 2011; Grieg-Gran, 2008) and cannot be simply seen as the low-hanging fruit of opportunity costs for REDD+ activities. In the short term, there may be situations, however, in which logging is not going to be followed by plantations (given that the extent of the areas being logged are larger that those being planted) and the opportunity cost for REDD+ activities focused on degradation would then be that of logging.

In addition to the benefits obtained by companies, which have normally been considered by studies of the opportunity costs of REDD+ (for example, Butler et al., 2009; Venter et al., 2009) the various levels of government also receive revenues from taxes and fees applied to land-use activities. Under all scenarios of discount rates, companies obtain a higher portion of the NPV than the government from the land-use activities considered, with the exception of commercial logging (Table 3).

The central government currently retains the largest shares of revenues from land-use activities compared with local governments. In the case of logging, the producing districts derive about half as much as the central government. The benefits derived by the districts from commercial logging mostly come from the

reforestation tax, given that 40 per cent of those revenues collected by the national government are returned to the producing regions. For the other land-use activities, local governments retain a very small share of the revenues. Although the portion of benefits received by district governments is meagre in comparison to the national level, in absolute terms they derive more from oil palm and timber plantations than from logging. Therefore, they too have a financial incentive to seek the conversion of forests to plantations.

Table 3. Average opportunity costs (NPV USD/ha) for private and public stakeholders (percentage allocation in brackets; 10% discount rate; palm oil price USD 800/t)

Alternative land-use activities	Company	Government Total	National	Provincial	Producing District	Other Districts
Commercial logging	206 (46.68)	235 (53.32)	140 (31.71)	6 (1.29)	69 (15.58)	21 (4.74)
Timber plantation without prior logging	1,037 (64.62)	568 (35.38)	536 (33.41)	7 (0.44)	14 (0.90)	10 (0.63)
Timber plantation with prior logging in degraded forests	1,507 (58.75)	1,058 (41.25)	767 (29.92)	29 (1.14)	213 (8.29)	49 (1.90)
Oil palm plantation without prior logging	6,355 (57.97)	4,608 (42.03)	4,587 (41.85)	3 (0.03)	17 (0.15)	0 (0)
Oil palm plantation with prior logging in degraded forests	6,458 (57.45)	4,782 (42.55)	4,678 (41.62)	10 (0.09)	82 (0.73)	13 (0.11)
Oil palm plantation with prior logging in primary forests	7,099 (56.34)	5,502 (43.66)	5,057 (40.13)	34 (0.27)	350 (2.78)	61 (0.48)

To assess whether the opportunity costs of REDD+ are competitive with the costs faced by developed countries to reduce emissions domestically, we consider the opportunity cost of carbon emissions. We compare the opportunity costs of REDD+ current carbon prices because the idea underlying the establishment of REDD+ is that it is supposed to be an early and relatively cheap way of reducing carbon emissions (Stern, 2007).

If only companies were to be compensated, it would be appropriate to consider

the costs resulting from the application of either the 10 or the 15 per cent discount rates. At these rates, the opportunity cost of REDD+ for all land uses, except for oil palm plantations on mineral soil with logging in degraded forest (Table 4), is competitive with the current price of carbon on the European market (EUA), which is in the range of US$16–17.[8] The establishment of oil palm plantations on peat soils has considerably larger carbon emissions than the other oil palm plantation types and presents, therefore, significantly lower opportunity costs.

From the government's perspective, the case of the 5 per cent discount rate may be more appropriate, however, for the reasons discussed earlier. In this scenario, commercial logging and oil palm plantations on peat soil with prior logging in primary forest (which is not supposed to take place according to the regulatory framework) have a total break-even cost well below current carbon prices (Table 4). Oil palm plantations on mineral soil with prior logging in primary forest (which is also not supposed to take place) have a total break-even cost similar to current carbon prices. The other two land uses present prohibitive costs (Table 4). It should be noted that while the opportunity cost of logging is competitive with current carbon prices, it is the first commercial activity that can take place in primary forests and, after years of logging, when forests become degraded, timber plantations are allowed, according to existing regulations, to clear-cut and replace the degraded forest. Therefore, the opportunity cost of commercial logging cannot be considered in isolation.

The sensitivity analysis (Table 5) shows that a lower price for palm oil would not make the opportunity cost of oil palm plantations in degraded forest competitive with current carbon prices if the government chose to use the 5 per cent

[8] http://www.pointcarbon.com, accessed June 5, 2011.

discount rate. At the other extreme, oil palm plantations in peat soil present a break-even price for carbon that is lower than current carbon prices – even with a higher palm oil price and a 5 per cent discount rate.

Table 4. Minimum REDD payments to offset opportunity costs

(USD/tonCO2eq; palm oil price USD 800/t)

Land-use activities	Carbon loss[#] (tCO_2/ ha)	Company	Government Total	National Gov	Provincial Gov	Producing District	Other Districts
			15% discount rate				
Commercial logging in primary forest	779.58	0.18	0.21	0.12	0.01	0.06	0.02
Timber plantation with prior logging in degraded forest	135.42	6.59	5.14	3.33	0.17	1.34	0.29
Oil palm plantation:							
- with prior logging in degraded forest on mineral soil	197.64	13.84	12.52	12.08	0.04	0.34	0.05
- with prior logging in primary forest on mineral soil	977.22	3.37	3.21	2.84	0.03	0.30	0.05
- with prior logging in primary forest on peat soil	2,249	1.34	1.37	1.20	0.01	0.13	0.02
			10% discount rate				
Commercial logging in primary forest	779.58	0.26	0.30	0.18	0.01	0.09	0.03
Timber plantation with prior logging in degraded forest	135.42	11.13	7.81	5.67	0.22	1.57	0.36
Oil palm plantation:							
- with prior logging in degraded forest on mineral soil	197.64	32.67	24.20	23.67	0.05	0.41	0.06
- with prior logging in primary forest on mineral soil	977.22	7.26	5.63	5.17	0.03	0.36	0.06
- with prior logging in primary forest on peat soil	2,249	2.95	2.39	2.20	0.02	0.16	0.03
			5% discount rate				
Commercial logging in primary forest	779.58	0.45	0.50	0.30	0.01	0.14	0.04
Timber plantation with prior logging in degraded forest	135.42	21.79	12.06	9.40	0.30	1.89	0.48
Oil palm plantation:							
- with prior logging in degraded forest on mineral soil	197.64	77.55	50.31	49.64	0.06	0.52	0.08
- with prior logging in primary forest on mineral soil	977.22	16.45	11.09	10.52	0.04	0.45	0.08
- with prior logging in primary forest on peat soil	2,249	6.76	4.71	4.46	0.02	0.19	0.03

Legend. # Emissions from primary and degraded forest on mineral soil based on Palm et al. (2004); emissions from forest on peat soil based on Venter et al. (2009).

Table 5. Sensitivity of minimum REDD payments to changes in the price of palm oil (USD/tonCO_2eq).

Discount rate:	5%		10%		15%	
Land-use activity and price of palm oil per ton	Company	Government Total	Company	Government Total	Company	Government Total
Plantation with prior logging in degraded forest – mineral soil						
USD 680	56.56	40.51	22.49	19.53	8.38	10.08
USD 800	77.55	50.31	32.67	24.20	13.84	12.52
USD 1,000	112.54	66.64	49.65	31.97	22.94	16.59
Plantation with prior logging in primary forest – mineral soil						
USD 680	12.23	9.11	5.22	4.69	2.27	2.72
USD 800	16.45	11.09	7.26	5.63	3.37	3.21
USD 1,000	23.49	14.39	10.67	7.20	5.18	4.04
Plantation with prior logging in primary forest – peat soil						
USD 680	4.93	3.85	1.56	1.98	0.86	1.15
USD 800	6.76	4.71	2.95	2.39	1.34	1.37
USD 1,000	9.82	6.14	4.43	3.08	2.13	1.73

5. Discussion

Previous estimates of the minimum REDD+ payment for oil palm plantations in Indonesia were in the range of US$9.85–33.44 per tCO_2 in mineral soil forests and US$1.63–4.66 per tCO_2 in peat areas (Venter et al., 2009) and US$7.66–19.24 per tCO_2 (Butler et al. 2009; without reference to soil types). Venter et al. (2009) assumed a carbon stock lower than other studies (for example, Butler et al., 2009; Palm et al., 2004; Palm et al., 1999) resulting in a higher estimate of the opportunity costs.

We demonstrate that, at current palm oil prices, using the higher carbon stocks reported in the literature, and a mid-range discount rate of 10 per cent, the minimum REDD+ payment to compensate for the opportunity cost amounts to

about US$57 per tCO_2 for the case of plantations on mineral soils and logging in degraded forest (the legal option). This estimate is well above those previously reported and, like the other estimates, does not include other costs, such as the management of REDD+ activities and transaction costs. Given that large areas of forest have been degraded – 55.6 per cent and 49.4 per cent of secondary forests in areas classified as production forests and in all areas classified as forests respectively (Ministry of Forestry, 2008b) – it seems that the establishment of REDD+ activities in those areas may be too costly if the development of oil palm plantations is an option.

The good news from this analysis is that all the other land-use activities (including oil palm on peat soil) present minimum REDD+ payments that are competitive with current carbon prices at the discount rates of 10 and 15 per cent. The minimum REDD+ payment to offset the opportunity costs of oil palm plantations on peat soil is always rather cheap, including in the case of a 5 per cent discount rate.

In relation to the distribution of the revenues for the different land-use activities, the foregoing analysis shows that the total revenues derived by the various government levels is very large, and in the case of commercial logging, exceeds that retained by the companies (Table 3). The national government obtains a very large share of the benefits, so it has a strong interest in promoting all types of land-use change. Going below the surface, each of the national level ministries (sectors) has different interests in the pursuit of the alternative land-use activities. The Ministry of Forestry has an interest in commercial logging in (natural) production forests to generate the lucrative reforestation levy. The Ministry of Forestry retains as much as 60 per cent of the fund and controls its utilisation to support nationally-based forestry programmes and policies (Barr et

al., 2009). In contrast, the Ministry of Agriculture, which is responsible for the promotion of agricultural development, promotes oil palm plantations and/or other agricultural activities in conversion forests, which total 22 million hectares. Revenues generated from oil palm plantations – which have reached 5.2 million hectares (Ministry of Agriculture, 2009 quoted by Rist et al., 2008) – mostly from the value-added tax and the corporate income tax, contribute to the national government's general income to finance a wide range of services.

As for local level governments, they receive a very small share of the revenues from the various land uses. However, they (particularly the producing districts) do receive benefits from timber and oil plantations. This explains the fact that forest agencies at the district level are interested in promoting timber plantations like their counterparts at the national level. The permits for commercial logging and timber plantations are issued by the Ministry of Forestry, although district governments can submit a proposal for activities at the district level (Resosudarmo et al., 2006). Local governments' support is also crucial for licences issued at the national level, as strong resistance from local stakeholders can hinder companies' operations, as reported in a number of regions in Indonesia.[9]

Local governments are also interested in expanding oil palm plantations in their localities (McCarthy and Cramb, 2009; Rist et al., 2010; Sandker et al., 2007; Zen et al., 2005). In the case of oil palm plantation, local governments have the authority to issue a business permit, which is required before the final decision on forest clearance can be made by the Ministry of Forestry (Colchester et al.,

[9] http://www.riaumandiri.net/rm/index.php?option=com_content&view=article&id=14559:datangi-kantor-bupati-meranti-ratusan-massa-demo-tolak-hti-&catid=40:riau-raya; http://dpd.go.id/2010/01/dpd-desak-menhut-hentikan-izin-usaha-hutan/, accessed on 11 June 2011.

2006). Therefore, district governments have more influence in this decision–making process compared with commercial logging and timber plantations. Although district governments obtain a small portion from the total benefits of oil palm, some regions apply a local fee, which is called a third-party contribution, to oil palm products.

The interests of district governments to support proposals for natural forest conversion to productive land-use activities could also be due to other economic and political benefits. Heads of districts might have a greater chance of maintaining their popularity if they attract investments and generate local revenues. Oil palm plantations, for instance, also generate employment and livelihoods for local people (McCarthy and Cramb, 2009; Rist et al., 2010; Sandker et al., 2007; Susila, 2004; Zen et al., 2005). Susila (2004) claims that oil palm activities can contribute as much as 63 per cent of smallholder household incomes in two locations in Sumatra. Sandker et al. (2007) simulated the impact of conversion of forests to oil palm in Malinau district (Kalimantan) and found that the total number of formal jobs created by oil palm development (22,000–120,000) could exceed the employment opportunities generated by mining, logging, and civil service put together (10,000). Moreover, Rist et al. (2010) reported that local elites obtained financial support during electoral campaigns by providing their support for the establishment of oil palm plantations.

6. Conclusion

This study demonstrates the interests of all stakeholders, companies and various government levels, in land-use change. It is shown that REDD+ might not be able to compete with some alternative land uses associated with very high opportunity costs, such as oil palm plantation in degraded forests on mineral

soils. REDD+ activities should first target activities that present low opportunity costs, such as the opening of natural forests. Oil palm and timber plantation companies are keen to operate in natural forests so that they can obtain additional logging income prior to their operations. When converted further to dollars per tCO_2, the additional benefit from logging income is very low, as logging natural forests results in very high emissions. Therefore, REDD+ payments could, for instance, be allocated to compensate stakeholders for relocating proposals for oil palm expansion from natural forests to non-forested areas or degraded forests. REDD+ would not halt oil palm expansion, but would help incentivise stakeholders to keep natural forests intact. Furthermore, REDD+ payments could also prevent the conversion of peat forests, as it results in extremely high emissions and it is therefore associated with low opportunity costs.

The design of the distribution of revenues generated from REDD+ activities should consider the specific incentives of the different government levels and across sectors, which have specific interests in promoting certain land-use changes. National REDD+ schemes should therefore consider the loss of public revenue at the subnational level arising from the restrictions on pursing productive activities in forest lands. Without proper compensation, subnational governments will have no incentives to support REDD+, as they would face forgone taxes, fees and shared-revenues, while the benefits of REDD+ reach far beyond their administrative boundaries (Ring et al., 2010). REDD+ payments, at the very minimum, should compensate the costs of REDD+ implementation, including opportunity costs (Boucher, 2008; Cattaneo, 2008; Strassburg et al., 2009). However, REDD+ payments based simply on the opportunity costs incurred by district governments may not result in changing local governments'

behaviours. District governments also see other benefits from the support of land-use change activities, such as job creation and other institutional benefits as mentioned before. Therefore, REDD+ schemes should provide a revenue stream that is higher than the alternative land-use activities in order to demonstrate that it is a superior option to the latter activities. The relevant government levels could therefore use those REDD+ payments to provide improved services to their citizens.

Finally, previous studies of the opportunity costs of REDD+ have not considered the influence of the discount rate on their results. This study demonstrates that the competitiveness of some avoided deforestation activities in terms of the opportunity cost of reduced emissions can be significantly affected by the choice of the discount rate. Both governments and those conducting further studies of the opportunity costs of REDD+ should therefore consider which discount rate might be most appropriate to their specific conditions, and carry out detailed sensitivity analysis.

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References

Andersson, K. P., Gibson, C. C., Lehoucq, F., 2006. Municipal politics and forest governance: Comparative analysis of decentralization in Bolivia and Guatemala. World Development, 34, 576-595.

Andrianto, A., Obidzinski, K., Wajdi, F., Tetuka, B., 2008. Deforestation and Forest Degradation in Papua Post-New Order Regime. Center for International Forestry Research (CIFOR), Bogor.

Barr, C., Dermawan, A., Purnomo, H., Komarudin, H., 2009. Financial governance and lessons from Indonesia's Reforestation Fund Center for International Forestry Research (CIFOR), Bogor.

Barr, C., Resosudarmo, I.A.P., Dermawan, A., McCarthy, J.F., Moeliono, M., Setiono, B., 2006. Decentralisation of forest administration in Indonesia: implications for forest sustainability, economic development and community livelihoods. Center for International Forestry Research (CIFOR), Bogor.

Bellassen, V., Gitz, V., 2008. Reducing emissions from deforestation and degradation in Cameroon: assessing costs and benefits. Ecological Economics 68, 336-344.

Boucher, D., 2008. Out of the Woods: A Realistic Role for Tropical Forests in Curbing Global Warming. Union Concerned Scientist, Cambridge.

Brojonegoro, B., 2004. Three years of fiscal decentralization in Indonesia: its impacts on regional economic development and fiscal sustainability Paper read at International Symposium on Fiscal Decentralization in Asia Revisited, Hitotsubashi, Chiyoda-ku, Tokyo, 20-21 February 2004.

Butler, R.A., Koh, L.P., Ghazoul, J., 2009. REDD in the red: palm oil could undermine carbon payment schemes. Conservation Letters 2, 67-73.

Cacho, O.J., Marshall, G.R., Milne, M., 2005. Transaction and abatement costs of carbon-sink projects in developing countries. Environment and Development Economics 10, 597-614.

Cattaneo, A., 2008. How to Distribute REDD funds Across Countries? A Stock-Flow Mechanism. The Woods Hole Research Center, M.A.

Colchester, M., Jiwan, N., Andiko, Sirait, M., Firdaus, A., Surambo, Pane, H., 2006. Promised Land: Palm Oil and Land Acquisition in Indonesia - Implications for Local Communities and Indigenous Peoples. Forest Peoples Programme, Perkumpulan Sawit Watch, HuMA and the World Agroforestry Centre, Bogor.

Fisher, B., Edwards, D.P., Giam, X., Wilcove, D.S., 2011. The high costs of conserving Southeast Asia's lowland rainforests. Frontiers in Ecology and the Environment 9, 329–334.

Forest Watch Indonesia, Global Forest Watch, 2002. The State of the Forest Indonesia. World Resources Indonesia, Jakarta.

FWI, GFW, 2002. The State of the Forest Indonesia. World Resources Indonesia, Indonesia.

Garnaut Review, 2011. Update Paper 1: Weighing the costs and benefits of climate change action. Garnaut Climate Change Review – Update 2011, Canberra.

Gregersen, H., Lakany, H.E., Karsenty, A., White, A., 2010. Does the Opportunity Cost Approach Indicate the Real Cost of REDD+? Rights and Realities of Paying for REDD+. Rights and Resources Initiative, Washington DC.

Grieg-Gran, M., 2008. The cost of avoiding deforestation: update of the report prepared for the stern review of the economics of climate change International Institute for Environment and Development, London.

Harrison, M., 2010. Valuing the Future: The Social Discount Rate in Cost-Benefit Analysis Visiting Researcher Paper. Productivity Commission, Canberra.

Houghton, R.A., 2003. Emissions and sinks of carbon from land use change. Report to the World Resources Institute from the Woods Hole Research Center, Washington, D.C.

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Intergovernmental Panel on Climate Change (IPCC).

Irawan, S., Tacconi, L., 2009. Reducing Emissions from Deforestation and Forest Degradation (REDD) and Decentralized Forest Management. International Forestry Review 11, 427-438.

Kaiser, K., Hofman, B., Kadjatmiko, Suharnoko Sjahrir, B., 2006. Evaluating Fiscal Equalization In Indonesia. Research Working papers 1, 1-36.

Kartodihardjo, H., Supriono, A., 2000. Dampak Pembangunan Sektoral terhadap Konversi dan Degradasi Hutan Alam: Kasus Pembangunan HTI dan Perkebunan di Indonesia. Center for International Forestry Research (CIFOR), Bogor.

Kindermann, G., Obersteiner, M., Sohngen, B., Sathaye, J., Andrasko, K., Rametsteiner, E., Schlamadinger, B., Wunder, S., Beach, R., 2008.

Global cost estimates of reducing carbon emissions through avoided deforestation. Proceedings of the National Academy of Sciences 105, 10302-10307.

Koh, L.P., Wilcove, D.S., 2008. Is oil palm agriculture really destroying tropical biodiversity? Conservation Letters 1, 60-64.

Lewis, B., 2005. Indonesian Local Government Spending, Taxing and Saving: An Explanation of Pre- and Post-decentralization Fiscal Outcomes. Asian Economic Journal 19, 291-317.

McCarthy, J.F., Cramb, R.A., 2009. Policy narratives, landholder engagement, and oil palm expansion on the Malaysian and Indonesian frontiers. Geographical Journal 175, 112-123.

Milne, M., 1999. Transaction costs of forest carbon projects. Centre for International Forestry Research (CIFOR), Bogor.

Ministry of Agriculture, 2009. Keynote address, MAKSI Conference, Bogor, November 24, 2009.

Ministry of Forestry, 2008a. Penghitungan Deforestasi Indonesia. The Ministry of Forestry, Indonesia, Jakarta.

Ministry of Forestry, 2008b. Rekalkulasi Penutupan Lahan Indonesia Tahun 2008. Ministry of Forestry, Jakarta, Indonesia.

Nawir, A.A., Murniati;, Rumboko, L., 2007. Forest rehabilitation in Indonesia: where to after three decades? Center for International Forestry Research (CIFOR), Bogor.

Nepstad, D., Soares-Filho, B.S., Merry, F., Lima, A., Moutinho, P., Carter, J., Bowman, M., Cattaneo, A., Rodrigues, H., Schwartzman, S., McGrath, D.G., Stickler, C.M., Lubowski, R., Piris-Cabezas, P., Rivero, S., Alencar, A., Almeida, O., Stella, O., 2009. The End of Deforestation in the Brazilian Amazon. Science 326, 1350-1351.

Pagiola, S., Bosquet, B., 2008. Estimating the costs of REDD at the country level. Center for International Forestry Research (CIFOR), Bogor.

Palm, C., Tomich, T., Van Noordwijk, M., Vosti, S., Gockowski, J., Alegre, J., Verchot, L., 2004. Mitigating GHG Emissions in the Humid Tropics: Case Studies from the Alternatives to Slash-and-Burn Program (ASB). Environment, Development and Sustainability 6, 145-162.

Palm, C.A., Woomer, P.L., Alegre, J., Arevalo, L., Castilla, C., Cordeiro, D.G., Feigl, B., Hairiah, K., Kotto-Same, J., Mendes, A., Moukam, A.,

Murdiyarso, D., Njomgang, R., Parton, W.J., Ricse, A., Rodrigues, V., Sitompul, S.M., van Noordwijk, M., 1999. Carbon sequestration and trace gas emissions in slash and burn and alternative land uses in the humid tropics. ASB Climate Change Working Group Final Report, Phase II, ASB Coordination Office, ICRAF, Nairobi.

Pirard, R., 2008. Estimating Opportunity Costs of Avoided Deforestation (REDD): Application of a Flexible Stepwise Approach to the Indonesian Pulp Sector. International Forestry Review 10, 512-522.

Resosudarmo, I.A.P., Barr, C., Dermawan, A., McCarthy, J.F., 2006. Fiscal Balancing and the Redistribution of Forest Revenues, in: Barr, C., Resosudarmo, I.A.P., Dermawan, A., McCarthy, J.F., Moeliono, M., Setiono, B. (Eds.), Decentralization of forest administration in Indonesia: implications for forest sustainability, economic development and community livelihoods. Center for International Forestry Research (CIFOR), Bogor, pp. 58-86.

Ring, I., Drechsler, M., van Teeffelen, A.J.A., Irawan, S., Venter, O., 2010. Biodiversity conservation and climate mitigation: what role can economic instruments play? Current Opinion in Environmental Sustainability 2, 50-58.

Rist, L., Feintrenie, L., Levang, P., 2010. The livelihood impacts of oil palm: smallholders in Indonesia. Biodiversity and Conservation 19, 1009-1024.

Rötheli, E., 2007. An analysis of the economic implications of developing oil palm plantations on deforestated land in Indonesia. . Worldwide Fund for Nature, Gland, Switzerland.

Sandker, M., Suwarno, A., Campbell, B., 2007. Ecology and Society: Will Forests Remain in the Face of Oil Palm Expansion? Simulating Change in Malinau, Indonesia. Ecology & Society 12, 37.

Smith, K., 2011. Discounting, risk and uncertainty in economic appraisals of climate change policy: comparing Nordhaus, Garnaut and Stern, Commissioned work. Garnaut Climate Change Review – Update 2011, Canberra.

Stern, Nicholas., 2007. The Economics of Climate Change: The Stern Review. Cambridge University Press, Cambridge.

Strassburg, B., Turner, R.K., Fisher, B., Schaeffer, R., Lovett, A., 2009. Reducing emissions from deforestation--The "combined incentives" mechanism and empirical simulations. Global Environmental Change 19, 265-278.

Susila, W., 2004. Contribution of oil palm industry to economic growth and poverty alleviation in Indonesia. Jurnal Litbang Pertanian 23, 107–114.

Tacconi, L., 2007. Decentralization, forests and livelihoods: Theory and narrative. Global Environmental Change 17, 338-348.

Tacconi, L., Mahanty, S., Suich, H., 2010. Forests, payments for environmental services and livelihoods, in: Tacconi, L., Mahanty, S., Suich, H. (Eds.), Payments for Environmental Services, Forest Conservation and Climate Change: Livelihoods in the REDD? Edward Elgar, Cheltenham, pp. 1-25.

Tropenbos International, 2010. Improving governance, policy and institutional arrangements to reduce emissions from deforestation and degradation (REDD) Tropenbos International, Indonesia.

Uryu, Y., Mott, C., Foead, N., Yulianto, K., Budiman, A., Setiabudi, Takakai, F., Nursamsu, Sunarto, Purastuti, E., Fadhli, N., Hutajulu, C.M.B., Jaenicke, J., Hatano, R., Siegert, F., Stüwe, M., 2008. Deforestation, Forest Degradation, Biodiversity Loss and CO2 Emissions in Riau, Sumatra, Indonesia. WWF Indonesia Technical Report, Jakarta.

Venter, O., Meijaard, E., Possingham, H., Dennis, R., Sheil, D., Wich, S., Hovani, L., Wilson, K., 2009. Carbon payments as a safeguard for threatened tropical mammals. Conservation Letters 2, 123-129.

Wertz-Kanounnikoff, S., 2008. Estimating the costs of reducing forest emissions: a review methods. Center for International Forestry Research (CIFOR), Bogor.

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