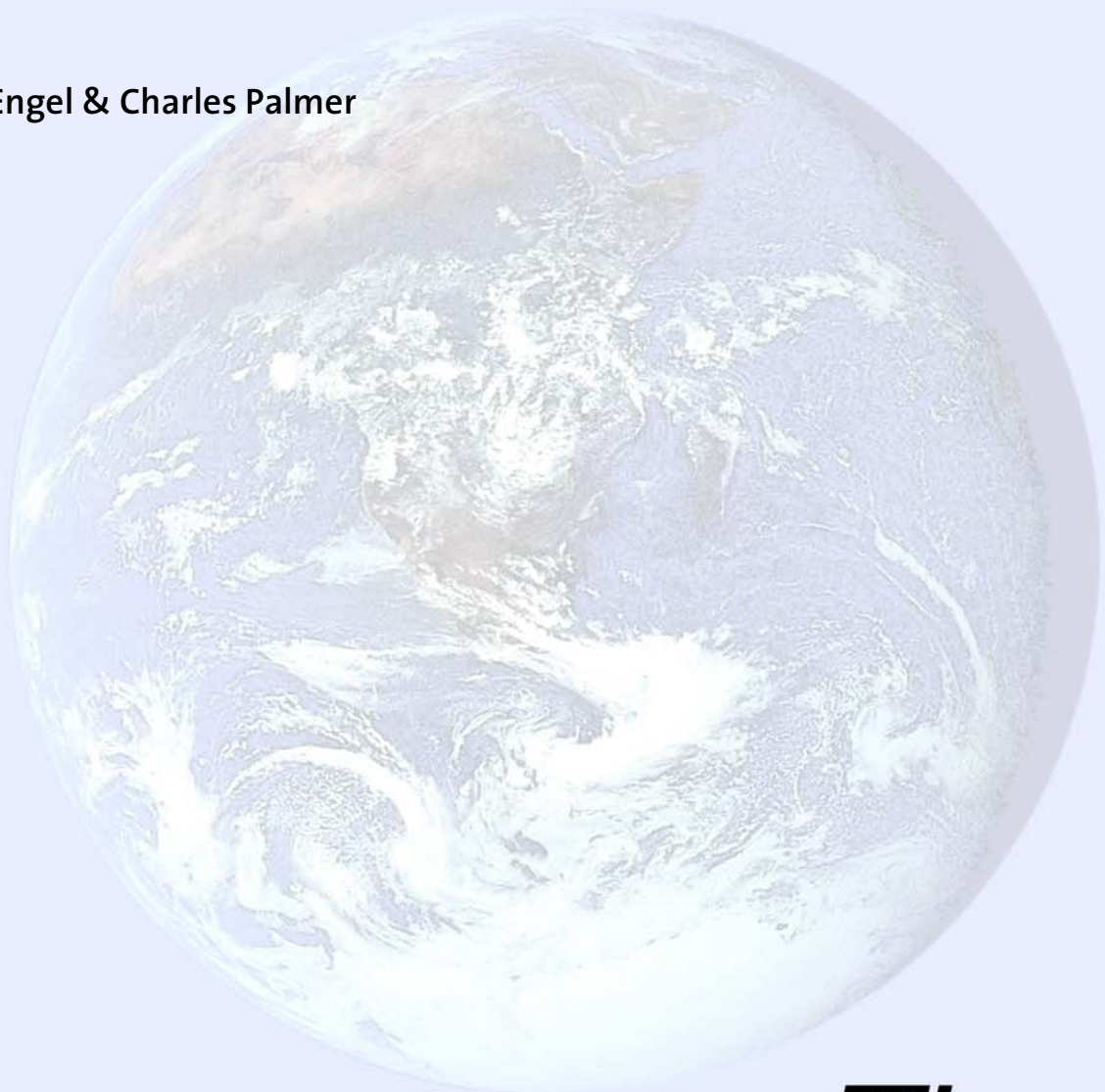


“Painting the forest REDD?” Prospects for mitigating climate change through reducing emissions from deforestation and degradation

Stefanie Engel & Charles Palmer



“Painting the forest REDD?”

Prospects for mitigating climate change through reducing emissions from deforestation and degradation¹

Stefanie Engel and Charles Palmer²

ETH Zurich, Chair of Environmental Policy and Economics, Department of Environmental Sciences
Institute for Environmental Decisions IED, Universitaetsstrasse 22, CH-8092 Zurich

1	Introduction	2
2	Forests, climate change and avoided deforestation	3
2.1	Impacts of climate change	3
2.2	Climate change policy	3
2.3	Forests as carbon sources and sinks	4
2.4	Avoided deforestation and climate change policy	4
3	The cost-effectiveness of avoiding deforestation	6
4	Policy and institutional barriers	7
5	Insights for effective and efficient REDD policy	9
6	Discussion	12
6.1	Role of REDD in global climate change mitigation	12
6.2	Permanence in REDD	13
6.3	Avoiding ‘hot air’	13
6.4	Changing results requires changing incentives	14
6.5	Governance and readiness	14
7	Conclusions	15
	References	16
	Endnotes	20

1 Introduction

Evidence for anthropogenic warming of the climate system as a consequence of greenhouse gas (GHG) emissions, including CO₂ (carbon dioxide), into the earth’s atmosphere is unequivocal (IPPC, 2007a). Annual CO₂ emissions from deforestation in tropical and sub-tropical countries accounts for up to a fifth of global emissions, the second largest source of all GHG emissions (Baumert et al., 2005). It also makes up more than a third of developing countries’ emissions. Conserving carbon stored in biomass could be a cost-effective strategy to mitigate future climate change impacts (see Stern, 2007; Chomitz et al., 2006). Reducing emissions from deforestation was, however, excluded from the climate change regime that resulted from the Kyoto Protocol negotiations held during the 1990s. The first commitment period of Kyoto is due to end in 2012. At the Bali Conference of the Parties (COP) in December 2007, countries agreed to create a mechanism for ‘reducing emissions from deforestation and degradation’ (REDD)³ as a potential component of a post-2012 climate change regime (UNFCCC, 2007).

More precise rules and modalities are to be developed by COP-15, which is due to take place in Copenhagen, in December 2009. Many open questions remain on how reducing deforestation could be credibly incorporated into a climate regime. There is therefore a need to take stock and consider the merits of such a mitigation strategy and how it might be implemented on the ground. This is the motivation for the edited volume, *Avoided Deforestation: Prospects for Mitigating Climate Change*, which assesses the potential of REDD mechanisms from the perspective of

economics and policy-making (Palmer and Engel, 2009). Due to be published by Routledge in March 2009, this volume highlights the importance of avoided deforestation as part of a global strategy to mitigate the build-up of anthropogenic GHG emissions in to the earth’s atmosphere. Incorporating deforestation could provide an opening for the active participation of developing countries in emission reduction efforts under an international climate change regime (Dutschke and Wolf, 2007).

This paper aims to introduce the role of forests in mitigating climate change and summarise some of the key issues and research covered in Palmer and Engel (2009). Section 2 presents the climate change problem, the role of forests and the policy debate so far. Section 3 focuses on research to assess the cost-effectiveness of avoided deforestation as a strategy to mitigate climate change, while section 4 examines the barriers to the adoption of such a strategy, primarily those related to policy and institutions. Section 5 looks at policy design, with a focus on overcoming additionality and leakage constraints and maximising the efficiency and effectiveness of potential avoided deforestation schemes. The main findings are analysed alongside some further issues for discussion in section 6. It should be noted upfront, however, that providing a full review of related literature is beyond the scope of this paper⁴. Excellent studies are constantly adding to the existing body of knowledge relevant for REDD policy design. Section 7 concludes by addressing some of the key, remaining open questions along with suggestions for future research.

2 Forests, climate change and avoided deforestation

According to widely-cited data published by the World Resources Institute (see Baumert et al., 2005), global anthropogenic GHG emissions, dominated by CO₂, are mainly given off via the burning of fossil fuels, and from agriculture and land-use changes. Emissions from deforestation and forest degradation occur as carbon stock is depleted and released to the atmosphere through changes in forest and other woody biomass stock, forest and grass land conversion, the abandonment of managed land, and forest fires. A 20 per cent decrease in forest area since 1850 has contributed to 90 per cent of emissions from land-use changes (IPPC, 2001). Throughout the 1990s around 1.5 billion tons of carbon (GtC) was released annually through deforestation (Gullison et al., 2007). Two countries, Indonesia and Brazil, dominate CO₂ emissions released through deforestation and as a result are, respectively, the third and fourth largest GHG emitters in the world, behind the United States and China (Houghton, 2003; cited in Baumert et al., 2005).

2.1 Impacts of climate change

Anthropogenic interference in the climate system is a real and growing threat to people, economies and the environment (Chomitz et al., 2006). On current trends, the average global temperature could rise by 2–3 °C within the next 50 years. This rise is likely to rapidly change the earth's climate, for example, leading to rising sea levels and a higher frequency of heat waves and heavy precipitation (IPPC, 2007a). Business-as-usual or 'baseline' climate change implies increasingly severe economic impacts if action is not taken to mitigate the worse effects.

Climate change can perhaps be characterized as the world's largest 'market failure' (Stern, 2007). The earth's atmosphere, into which anthropogenic GHG are emitted, is a global public good, i.e. it is non-rival and non-excludable. These emissions are an externality in that those who produce them impose social costs on the world

and future generations but do not face the full consequences of their actions. The actual source of emissions, whether producer or consumer, rich or poor, is irrelevant to the overall growth in global GHG stocks and the corresponding future changes in the climate. Nevertheless, the worst impacts of climate change are expected to fall disproportionately on people living in some of the poorest regions of the world. People living in these regions are the most vulnerable to adverse changes in, for example, food production and water resources.

2.2 Climate change policy

The global causes and consequences of climate change imply the need for international collective action for an efficient, effective and equitable policy response. The first global attempt to put a price on the social costs of emissions by stabilizing the amount of GHG in the atmosphere was seen in the formation of the United Nations Framework Convention on Climate Change (UNFCCC). Ratified by 182 Parties as of May 2008 (UNFCCC, 2008), the Kyoto Protocol of the UNFCCC originally entered into force in 2005. It committed Annex I, mainly industrialized countries to reducing their collective GHG emissions by about five per cent below their 1990 levels by 2008-2012. In fulfilling these commitments, countries are able to achieve reductions in their emissions through several mechanisms including the Clean Development Mechanism (CDM). The CDM allows entities in non-Annex I countries to develop 'offset' projects leading to verified reductions in GHG emissions emitted from Annex I countries. So-called Certified Emissions Reductions (CERs) are then transferred to Annex I countries at a price set by the carbon markets.

Reducing GHG emissions in order to stabilize the climate requires the deployment of a portfolio of GHG emissions-reducing technologies along with the application of appropriate and effective incentives (IPCC, 2007). These include adaptation and mitigation measures such as carbon

storage and capture and reducing deforestation, all with varying, generally uncertain costs. None of these measures on their own, for example, the halting of all deforestation, would achieve the UNFCCC’s goal (Pacala and Socolow, 2004). But conserving forest carbon could likely be an important part of the climate change solution, particularly if it proves to be cost-effective compared to other mitigation options (see Stern, 2007; Chomitz et al., 2006). Negotiations on the types of admissible projects in Kyoto included a range of options for increasing forest stock and removing carbon from the atmosphere. Reducing emissions from deforestation was discussed, but was finally excluded from the CDM (see below).

2.3 Forests as carbon sources and sinks

The Forest Resources Assessment (FAO, 2006), estimated that a third of the earth’s land surface, up to four billion hectares, is covered by forest. Of this, around half is located in the tropics and sub-tropics. The largest intact tropical forests are found in the Amazon Basin (Brazil), the Congo Basin (Democratic Republic of the Congo) and in the Indo-Malayan region (Indonesia, Malaysia and Papua New Guinea). These forests provide important traded and non-traded environmental goods and services, including carbon. Tropical forests have particularly high carbon stocks, perhaps holding as much as 50 per cent more carbon per hectare than forests in other regions (Houghton, 2005). In terms of economic value, even relatively low traded carbon values have been found to comfortably dominate the non-market values of other tropical forest environmental services (see Pearce et al., 2002). These include direct use values, although perhaps excluding the returns from unsustainable timber extraction.

Over the past century, tropical deforestation and forest degradation have increased dramatically. The former occurred at an average rate of 13 million hectares per year, between 1990 and 2005 (FAO, 2001; 2006). Brazil and Indonesia accounted for, on average, around 40 per cent of annual deforestation by area over this period. The causes of the continuing loss and degradation of tropical forests are many, varied and complex (Chomitz et al., 2006; Geist and Lambin, 2002; Kaimowitz and Angelsen, 1998). However, understanding these is important for the design and

implementation of policy to reverse their effects, whether related to policy to reduce CO₂ emissions or not. This requires identifying the underlying market and policy failures and understanding how these relate to activities both inside and outside the forest sector. The latter include those related to agriculture, migration and infrastructural development. Recent government and non-government efforts to slow down or reverse overall deforestation and degradation trends, either through forest policy or policy made in other sectors have been relatively unsuccessful for various reasons (see Bulte and Engel, 2006). Given the many inter-linked pressures on forests, the challenge now for climate policy is to design a strategy for capturing the carbon value of natural forest stock that is not only effective but also efficient and equitable.

2.4 Avoided deforestation and climate change policy

Without effective policies to slow deforestation, business-as-usual tropical deforestation could release up to 130 GtC by 2100 (Houghton, 2005). ‘Avoided deforestation’ is a concept where countries are compensated for preventing deforestation that would otherwise occur (Chomitz et al., 2006). Reducing emissions by slowing deforestation could be a substantial and important component of climate mitigation policy, and has been discussed as such by researchers and policy-makers for a number of years (see, for example, Brown et al., 1996; Schneider, 1998). The available evidence shows that potential carbon savings from slowing tropical deforestation could contribute substantially to overall emissions reductions. Moreover, forests protected from deforestation could persist in the coming decades despite ‘unavoidable’ climate change (Gullison et al., 2007). Possible side benefits from the realization of natural forest carbon values include other forest environmental values such as biodiversity.

Avoided deforestation projects were excluded from the 2008-12 first commitment period of the Kyoto Protocol’s CDM due to a number of concerns revolving around sovereignty and methodological issues (Fearnside, 2001; Laurance, 2007). The former arose as a consequence of forests *per se* not being considered as a global public good despite the public good nature of some forests services. Since exclusion, discussions have been ongoing to try to

resolve these concerns through, for example, the UNFCCC's recent 2-year initiative (Subsidiary Body on Scientific and Technical Advice or SBSTA). This has acted as a useful forum for assessing new policy approaches and incentives for avoided deforestation in developing countries. Note that the SBATA process included discussions about emissions from forest degradation, thus expanding the scope of potential policy mechanisms from RED (Reducing Emissions from Deforestation, or avoided deforestation) to REDD. Meanwhile tropical forest nations such as Papua New Guinea, Costa Rica and Brazil have been floating various initiatives to protect forests through utilizing their value as carbon sinks.⁵ Forest carbon finance has also been endorsed by the United Nations, the World Bank, and the majority of nation states, with the Bank's Forest Carbon Partnership Facility (FCPF) aiming to attract US\$ 300 million in donor funding for pilot REDD schemes (World Bank Carbon Finance Unit, 2008). With support from Australia, Indonesia is hoping to be the first country to develop

and host a REDD project, beginning in late 2008 (Jakarta Post, 2008).

The Bali COP is part of an ongoing process that will carry on through 2008. It is hoped that a post-2012 international climate regime will be agreed by the end of 2009 at COP-15 in Copenhagen. Whether or not avoided deforestation or REDD will be included in a final framework agreement and what this arrangement might look like is beyond the scope of this paper⁶. Instead, and for the most part, it looks at what might be gained from including REDD as a feasible option in a post-Kyoto agreement and at how some of the challenges of such inclusion could be tackled from the perspective of economics and policy-making. The following three sections, respectively, investigate the cost-effectiveness of avoiding deforestation or REDD, the policy and institutional barriers to implementing REDD and some insights for effective and efficient REDD policy.

3 The cost-effectiveness of avoiding deforestation

Different approaches have been employed by researchers to estimate the costs of avoiding deforestation. In general, because avoiding deforestation involves a change in land use, opportunity costs (i.e., the costs of foregone net benefits from the next best alternative activity) tend to constitute the most important source of costs. Building on background research carried out for the Stern Review (Stern, 2007), Grieg-Gran (2009) examines the cost-effectiveness of avoided deforestation as a mitigation option using empirical data for eight tropical countries. Her estimates of average opportunity costs per tonne of CO₂ avoided range from US\$1.2 to 6.7, depending on the scenario under consideration. Grieg-Gran also highlights the spatial variation in cost estimates across countries. While perhaps 'cheap' in say parts of Africa, avoided deforestation may turn out to be less cost-effective in Indonesia, depending on land use. Additionally, Grieg-Gran incorporates administration costs into her estimates. These particular transactions costs range from US\$0.1 to US\$0.2 per tonne of CO₂. Average cost estimates overall compare favourably with most other mitigation options, although higher transactions costs could potentially account for a substantial proportion of the total cost per tonne of CO₂ avoided through reducing deforestation⁷.

Combating deforestation will, of course, still require substantial funds. Rametsteiner et al. (2009) develop a global land use model, which indicates that a 50 per cent reduction of carbon emissions from deforestation over the next 20 years would require financial resources of some US\$33 billion per year. This is a figure that easily exceeds all current annual Overseas Development Assistance (ODA) spending on forestry. Given that ODA alone would fall short of funding requirements, a combination of funding sources and policy mechanisms would be required for reducing emissions from avoiding deforestation. Carbon trading, now active in various forms all over the world, could be one potential component of funding. Using a global timber market model, Sohngen (2009) confirms the conclusion that carbon credits for reductions in deforestation may be cheap in comparison to other options both in forestry, e.g. afforestation, and in the energy market. In a related study, Tavoni et al. (2007), found that reductions in deforestation can achieve levels of annual sequestration similar to those achieved with carbon capture and storage but earlier and at lower prices. These studies⁸ highlight the need to include avoided deforestation or REDD as a mitigation option in global climate change models. Currently, these models often ignore this option.

4 Policy and institutional barriers

There are a number of important policy, institutional and methodological barriers that prevented the inclusion of REDD strategies in the Kyoto Protocol, although progress has been made since to overcome these (Johns and Schlamadinger, 2009). It seems that the most contentious issue relates to the financing of REDD activities. The challenge is to provide adequate, consistent, long-term funding of REDD activities, while also providing real and additional climate benefit. Developing countries have been arguing strongly that financial assistance for REDD should not be drawn from existing development-funding streams.

Current proposals mostly fall into one of three categories: (i) trading REDD credits in the carbon market (similar to CDM Afforestation/Reforestation credits); (ii) a voluntary, fund-based approach not linked to the carbon market; and (iii) indirect market approaches, drawing proceeds from the market but without a direct link to market credits. Hybrid approaches appear promising, in that they could capture the larger financing potential of the market while benefiting from advantages of a fund, such as allowing for equity and biodiversity considerations in targeting. Alternative or complementary funding could be obtained through a tax on Kyoto mechanisms and/or on emissions from international air and maritime transport or through an obligatory contribution by Annex I countries to a revolving compliance fund (Dutschke and Wolf, 2007). Another issue is whether a REDD mechanism should follow a CDM-type project-based approach, a national approach, or a 'nested' approach. A strong argument for a national approach relates to the issue of 'leakage', i.e., the possibility that REDD in one area may be at least partially offset by increases in deforestation and degradation elsewhere. While international leakage can still occur under a national approach, it could be addressed in different and separate ways compared to the leakage that might occur at the sub-national project scale (see section 5).

Significant progress has been made in identifying and analysing the large range of drivers of deforestation at varying spatial scales (Chomitz et al., 2006). It is clear that any feasible REDD mechanism needs to be built on an understanding of these drivers and be flexible enough to support solutions tailored to specific local and regional conditions. A limited capability to monitor deforestation and estimate forest-based emissions has long been another barrier to the inclusion of REDD in an international climate regime. Recent advances in the field of remote sensing in combination with appropriate ground truthing provide a solid basis, as described both in Johns and Schlamadinger (2009) and by Moutinho et al. (2009). The remaining uncertainties can be treated by taking lower-bound estimates of the quantity of emissions reduced. Yet improvement in access to data and training in new technologies is still required. The degree to which forest degradation and forest regrowth are to be considered as activities included in a REDD mechanism is another crucial issue still to be resolved. While there are good reasons to include both activities, the difficulty and increased cost involved in emission monitoring and estimation poses a real challenge. Baseline setting, i.e. the estimation of rates of change in say deforestation rates or emissions levels in the absence of policies to change these, is another highly political issue, which is discussed in further detail below.

Institutional barriers, while they have not been the centre of negotiations thus far, have now increasingly become a focus of attention and discussion, as countries, NGOs, and financing institutions grapple with the so-called 'readiness process'. This is supposed to ascertain what it will take for a country to be ready to participate in an international REDD mechanism (Dutschke, 2008). Institutional barriers include, e.g., appropriate land tenure and forest protection law; adequate capacity for monitoring and enforcement; and effective engagement of civil society, including forest-dependent and indigenous communities.

Moutinho et al. (2009) along with Palmer and Obidzinski (2009) discuss some of the above issues as they relate to the two main contributors of CO₂ emissions from forestry and land use changes in the world: Brazil and Indonesia, respectively. In addition to illustrating some of the country-specific policy and institutional challenges in more detail, these researchers highlight the fact that REDD requires a coordination between different levels of governance of the implementing country (from local to national) as well as across different sectors of the economy. Policy reforms and initiatives are ongoing in both countries that would go hand-in-hand with an international mechanism.

Moreover, the important point is made that pressures on forests, whether in the absence or presence of an effective REDD mechanism, are likely to increase. Increases in agricultural product prices such as biofuels, exchange rates effects and road construction may all enhance pressure on forests, yet are often ignored in baseline estimation. In Indonesia the situation is particularly dramatic as growing demand for timber products and biofuels have driven Indonesian government plans for a massive expansion of these sectors. This expansion is supported through substantial government subsidies including the use of timber stands as collateral in plantation development. These have the effect of reducing deforesters' costs with implications for the estimation of deforestation baselines. Palmer and Obidzinski (2009) draw attention to the potential that the prospect of an international REDD mechanism may induce perverse incentives, by slowing the reforms necessary to

correct government failures, in order to achieve higher baselines. This may, however, be more of an issue with the adoption of a business-as-usual baseline projection rather than one drawn from a historical reference period. In Brazil, land speculation and 'land grabs' by prospective landowners, and driven by agricultural commodities' and livestock prices, have long dominated deforestation behaviour at the Amazon frontier. Property rights claims underlying such behaviour raises similar baseline issues as in Indonesia but may also present opportunities in the context of a REDD payment regime, as discussed further below in section 6.

Michaelowa and Dutschke (2009) pick up on one of the major concerns related to including REDD credits in the carbon market: the fear that the potentially large supply of carbon credits from reducing emissions through avoiding deforestation could upset the balance of the market. The authors estimate and project expected credit supply and market demand scenarios for carbon until 2020. Their supply analysis incorporates governance problems plaguing most countries with high deforestation rates, while demand is determined by the relative stringency of the climate policy regime. They find that, due to governance problems in many tropical countries, the credit supply from REDD would pick up slowly during the initial years of programme implementation. Nevertheless, any integration of credits from reducing emissions through avoiding deforestation into the carbon market should be accompanied by long-term target setting.

5 Insights for effective and efficient REDD policy

This section addresses the issues of leakage estimation, baseline setting, dealing with tradeoffs in objectives, and increasing the efficiency of current mechanisms compensating for avoided deforestation.

Murray (2009) focuses on the importance of recognizing, estimating, and where possible ameliorating the risks of leakage from compensation policies that are likely to be applied to a subset of countries with deforestation potential. He illustrates some of the different approaches that can be used to estimate leakage empirically and of the relatively small number of studies that have attempted to do so to date. The results of these studies suggest that international leakage from avoided deforestation policies could be substantial if not addressed in policy design. One way to reduce leakage is to expand the scope of policy coverage as wide as feasible. Scope expansion could involve covering more countries or more activities.

However, an important point made by Murray is that expanding the number of countries involved in a voluntary system involves the balancing act of enhancing incentives for their participation through, among other things, generous baselines against the need to maintain the environmental integrity of the system by not crediting 'hot air'. Expanding the scope beyond deforestation may both help lure countries with low baseline deforestation rates into the system and ensure that deforestation emissions are not reduced at the expense of carbon losses elsewhere in the forest sector. Covering all forest carbon in an international compensation system raise, however, some concerns about spurring land use changes that could potentially undermine other environmental objectives such as biodiversity and water provision unless addressed via agreed-upon protocols, e.g. discouraging the conversion of native ecosystems to plantations.

As mentioned above, one crucial issue for any REDD mechanism is the setting of the hypothetical baseline (or business-as-usual projection) against which REDD progress is measured. A baseline for forest conservation has two main components: the projected land-use change and the corresponding carbon stocks in applicable pools in vegetation and soil. For the latter, there are now standard values recommended by the Intergovernmental Panel on Climate Change (IPCC) for different vegetation types that can be used (Dutschke and Wolf, 2007). The most commonly discussed method for baseline estimation is the use of some sort of national historical reference period of emissions from deforestation. Alternative, more sophisticated approaches have been proposed, as described both by Johns and Schlamadinger (2009), and Murray (2009). These include more or less sophisticated projections of past trends into the future or a normative baseline.

Harris et al. (2009) emphasize the need for a standardized, scalable baseline approach that is accurate, transparent, credible and conservative. They briefly review three specific models for baseline estimation applied elsewhere and evaluate how they differ in terms of transparency, accuracy and precision, applicability at various scales, compatibility with international requirements, and cost-effectiveness in terms of data, time, and expertise needed for application. They then describe in detail a spatial modelling approach that ranked highest in their evaluation. The so-called GEOMOD approach is interesting because it can be used to estimate a deforestation baseline at the project, regional or national scale and to predict the spatial location of deforestation. A weakness of the approach is that estimated overall rates of deforestation are based purely on historic rates, while driving factors are used to predict location only. Such weaknesses, however, need to be considered in light of the overriding need for setting the most objective, transparent and comparable REDD standards possible at the international level.

Pfaff and Robalino (2009) further demonstrate the importance of correct baseline estimations. They explain how impact evaluation and policy planning are complicated by several factors: the inability to observe how land choices would have differed without a policy; the fact that policy location may be affected by private and public choices; and the spatial and temporal interactions among land use choices. Using empirical examples from Costa Rican policies, specifically the widely-cited payments for environmental services (PES) policy and Costa Rican parks and protected areas, the authors convey how impact analysis could address these hurdles. Pfaff and Robalino’s results also show that forest conservation policies that appeared to have been very successful at first sight may have added much less in the way of conservation benefits once the appropriate baselines are considered. In other words, once policy impacts were evaluated in a thorough manner, conservation policy resulted in much lower levels of ‘additionality’ than was originally expected. These results have two important implications for REDD. First, they cast doubt on very simplistic baseline approaches, e.g. those based on simple historic deforestation data. Second, they highlight the need for more efficiency in conservation spending.

Finding ways to increase the efficiency of forest conservation spending, whether at the international, national or sub-national level, is important for several reasons. First, the actual cost of REDD will depend on how efficiently available funding is used, which in turn depends on the design of a future REDD mechanism. If REDD is to be achieved through the establishment of some type of international fund like the Amazon Fund⁹, the fact that financial sources are limited requires a procedure for deciding which countries, regions or projects are selected for REDD funding. Moreover, increasing the efficiency of current forest conservation spending can be seen as an important complement to a strategy of raising additional funds for reducing carbon emissions through avoided deforestation. As argued by Engel et al. (2009) in work on funds’ targeting in Costa Rica’s PES scheme, demonstrating efficiency can be important in attracting new funding sources, particularly from the private sector. By increasing the efficiency of existing programmes, funds can be freed up for additional programmes, or for inclusion of additional sites in a given programme (‘achieving more bang for the buck’).

Both increasing cost-effectiveness of funding and dealing with institutional or policy-related barriers on the ground requires a careful consideration of policy choice and policy design. There are a variety of policies that could be applied to avoided deforestation from so-called ‘command and control’ instruments such as state protected areas to ones based on a market mechanism (see Gupta et al., 2007). Policy choice may depend on a number of factors including the source(s) of market failure and in the particular case of deforestation, the identification and level of understanding of the drivers and agents of deforestation (Engel et al., 2008).

PES, the focus of both Engel et al. (2009) and Alix-Garcia et al. (2009), are an increasingly used instrument both for financing and implementing forest conservation and thus have potential in application to payments for REDD. The relevance of PES to the REDD debate is demonstrated by cost studies such as Grieg-Gran (2009), which tend to assume that some type of PES will be put in place to compensate land owners (or land users) for the profits forgone by avoiding deforestation. The defining characteristic of PES lies in its conditionality (Wunder, 2005): payments are made by an environmental service buyer conditional on the environmental services provided by an environmental service seller. Such ‘beneficiary pays’ positive incentives have not only been shown to be relatively more cost-effective compared to more indirect conservation approaches (see Ferraro and Kiss, 2002) but may also be politically more acceptable than instruments such as taxes on forest products or land clearance¹⁰.

The Costa Rican national PES scheme is often considered a pioneer and leading model of PES. Payments there are made largely for avoided deforestation, although as shown by Pfaff and Robalino (2009), these have not had the impact on deforestation rates claimed by the scheme’s proponents. In establishing a national or regional PES scheme, questions arise on how land parcels are selected for programme inclusion, and about the size and allocation of conservation payments. Voluntary PES projects within a country could lead to the leakage of emissions to non-enrolled parcels. While national accounting may capture this, there will still be efficiency issues, which could be at least partially dealt with through improved payments targeting. Engel et al. (2009) show that the amount of environmental services achieved with a given budget for a

region in Costa Rica could be nearly doubled through improved targeting in site selection. In particular, they develop a tool for selecting among applicant sites on the basis of three criteria: the amount of environmental services provided by the site; the probability that these services would be lost in the absence of PES (additionality); and the cost to land owners of providing the services. Alix-Garcia et al. (2009) find similar efficiency gains when targeting is considered for the national PES scheme in Mexico.

Engel et al. (2009) along with Alix-Garcia et al. (2009) both deal with issues related to national-level schemes¹¹. The lessons drawn from these chapters can also, to some extent, be applied to international-level mechanisms. The CDM is an example of an international PES scheme. One of the main declared objectives of the World Bank's prototype Forest Carbon Partnership Facility (FCPF) is to test a system

of performance-based incentive payments for REDD services. There is considerable spatial variation in the carbon content of forests. Moreover, a fund-type REDD mechanism may also want to consider additional environmental services like biodiversity conservation, or equity arguments, all of which can in principle be integrated as targeting criteria for PES, as demonstrated by Engel et al. (2009). Threat levels and opportunity costs may vary even more in space. Some of the methods presented elsewhere in Palmer and Engel (2009) could be applied here; e.g., the estimation of location specific deforestation baselines à la Harris et al. (2009). Engel et al. (2009) and Alix-Garcia et al. (2009) also discuss scientific, administrative and political challenges of targeting and how these may be overcome. Such challenges may be even greater at the international level. Efficiency gains need to be weighed against political feasibility and increases in implementation costs.

6 Discussion

In this section, some further thoughts are presented relating to the role of REDD in climate change mitigation, permanence in REDD carbon benefits, the importance of incentives and avoiding 'hot air' credits, and governance.

6.1 Role of REDD in global climate change mitigation

There are several reasons why the inclusion of REDD, or at least RED (avoided deforestation), in an international climate regime should be considered as part of a portfolio of mitigation options alongside an agreement containing stringent curbs in global GHG emissions.

First, as demonstrated by Michaelowa and Dutschke (2009), modest emissions reduction targets imply that in the mid-term a glut of REDD credits may lead to low carbon prices that remain low. Cheap prices for combating climate change while intuitively a good thing for climate policy (see Chomitz et al., 2006) may dampen incentives for more long-term investments in other mitigation options such as improving energy efficiency (Kremen et al., 2000; Schneider, 1998). This may have serious implications for long-run climate policy objectives, although technological change needs to be complemented with public investment in research and development as well as price incentives. For the worst predicted effects of climate change to be overcome, sharp curbs of perhaps up to 70-80 per cent of current global emissions may be required (IPPC, 2007b)¹². In 2008, cuts of 50 per cent were agreed, in principle, by the Group of Eight (G8) at its annual meeting, which are expected to be achieved by 2050 (G8, 2008). Since deforestation accounts for around a fifth of current emissions, it is obvious that incentives will also be necessary to ensure emissions reductions in other sectors, particularly energy production, transport, and industry, in order to realise ambitious global targets (IPPC, 2007b). A glut of REDD credits could potentially send out price signals that would not be sufficient to push producers and

consumers towards a low-carbon economy over the coming decades. On the other hand, today's cheap REDD potential may decrease with every year that it is not taken advantage of while the reduction of energy-related emissions could become more accessible over time with technological advancement. It is possible, however, that uncertainty about the supply of REDD credits, particularly in the early years of scheme implementation, might make it difficult to tune the supply-demand balance in a CDM or allowance type approach.

Second, in the event of considerable global warming occurring, there is a risk that forests, even if conserved by society, may be severely damaged by climate change, which could trigger a chain reaction of forest die-off and carbon release that would be difficult to stop (see Nepstad et al., 2008). Thus, an important point made by Chomitz et al. (2006) and emphasised by Michaelowa and Dutschke (2009) is that REDD credits can contribute most in a climate change mitigation scenario of high stringency.

Third, the inclusion of REDD as a low-cost mitigation option may be needed in order to provide incentives to bring more emitters into a collective climate agreement post-2012. Given the relative cost-effectiveness of REDD as compared to other mitigation options, including REDD (or at least RED) in a global strategy to combat climate change could increase the likelihood of both getting industrialized countries to agree to stricter targets (if REDD credits can be used to meet these targets) and getting developing countries on board as well. In this sense, the large potential magnitude of REDD credits may be seen as a hope rather than a concern (Chomitz et al., 2006). For example, developing countries inspired by the Brazilian government's initiative (see Moutinho et al., 2009) are keen to see industrialised countries reduce rather than simply offset their emissions elsewhere. While some major emitters such as those in the EU might agree with this position, others such as the US and Japan may like to see a larger role for emis-

sion offsets than is presently allowed under Kyoto. A compromise between the extreme 'domestic reductions' and 'offsetting' positions may be the best hope of getting not just as many countries as possible to agree on a single climate regime but also one that commits the Parties to stringent emissions reductions.

6.2 Permanence in REDD

An issue that was only marginally addressed in Palmer and Engel (2009) and one that is closely related to the previous point is that of permanence, i.e., whether emissions from deforestation and degradation are reduced for good and not simply shifted to another period (Murray, 2009). A lack of permanence can, in principle, be viewed as a form of 'temporal leakage', similar to spatial leakage discussed earlier. As forest systems interact with climate and hydrological systems, unforeseen changes may occur including feedback effects and forest 'die-back'. Moreover, local deforestation may vary with market conditions, leading to unexpected outcomes. For example, biofuel policies may increase the demand for arable soils, thereby increasing emissions from deforestation. The approach of temporary crediting applied under the CDM could also be an option for REDD. However, the flipside is that the market value of a temporary emission allowance can be very low, as it depends on price expectations for the subsequent commitment period. Countries might thus prefer to take over liability for longer periods, while insurance could help reduce the risk of non-permanence in emissions reductions. The former point implies the need for institutions that would be able to hold countries to their long-term commitments.

Most current proposals include a carry-over of commitments to the subsequent commitment period in case deforestation has increased beyond the agreed upon level, combined with some obligatory banking of some share of the credits (Dutschke and Wolf, 2007). Averaging emission reductions over longer commitment periods, e.g., of ten years, would also help to deal with difficulties in predictability (ibid). Within countries, incentive mechanisms like PES could be more directly linked to market prices. Even if a significant portion of REDD turns out to be non-permanent in the longer run, REDD may still serve an important role in bridging the time to a less CO₂-intensive global economy (Lecocq and Chomitz, 2001)¹³. The idea of 'carbon rental'

may also get around the problem of locking-in certain land uses in perpetuity, which has been perceived by some countries as an infringement of sovereignty over their natural resources (Laurance, 2007). Moreover, the idea of perpetuity is simply not feasible in many developing countries given unstable political and economic conditions, all of which implies that at most REDD can create temporary carbon credits in these countries.

6.3 Avoiding 'hot air'

The issues of additionality, permanence, and leakage have been cornerstone concerns for project-based GHG mitigation policy (Murray, 2009). The fear is that REDD could become a feel-good market, achieving insignificant real emissions reduction (CIFOR, 2008). Indeed recent empirical evidence on the lack of additionality of existing forest conservation policies, some of which has been summarised above, reinforces the need for solid baseline assessment. As Harris et al. (2009) put it, the development of an accepted, standardized baseline approach for avoided deforestation activities is therefore a key step towards the adoption of any future REDD mechanism. Such an approach also needs to balance the gains from more accurate baseline estimates against the associated costs. A major challenge in this regard is to agree on a method that could effectively incentivize emissions reductions in high-deforestation countries, while still supporting the maintenance of forests that may be under more threat of deforestation or degradation in the future (Johns and Schlamadinger, 2009). Potential REDD mechanisms that can minimise hot air at the international level should be given serious consideration, e.g. see Strassburg et al. (2008).

Another important point made by Murray (2009) is the potential tradeoff between increasing additionality and decreasing leakage: the less stringent baselines are set, the greater the incentive for a large number of countries to participate in a REDD mechanism which will help control international leakage. There is also some urgency in agreeing on baselines. Palmer and Obidzinski (2009) clearly demonstrates the potential for perverse behaviour, with the adoption of a business-as-usual baseline approach leading to increased deforestation and reduced incentives for policy reform. A related issue, and one that may partly help to address the above challenges, is the optimal length of baseline projection. For example, Harris et al. (2009)

propose a project length of 20-60 years, but with baselines ‘locked in’ for 10 years only (see also, Sohngen, 2009).

6.4 Changing results requires changing incentives

The importance of incentives is stressed throughout Palmer and Engel (2009). It is important to acknowledge that at the local level deforestation is usually a profitable activity. To some degree this also holds at the country level as halting deforestation can imply forgone economic development. Yet policy failures are also widespread at that level, resulting in above optimal deforestation rates even from the national perspective. A PES-type mechanism appears promising both at the international and the within-country level. Particularly, making incentives conditional on actual REDD performance is an essential part of avoiding ‘hot air’. Paying nations contingently on their REDD performance also opens up options to leverage policy reforms (CIFOR, 2008). At the local level, bundling REDD with other environmental services like biodiversity conservation or hydrological services may help raise additional funds for avoiding deforestation. Again, whether a national PES scheme is the best approach for individual countries in achieving compliance with national REDD commitments will depend on the underlying sources of deforestation and on the governance system in place. For example, where deforestation is driven by credit market imperfections or perverse incentives in other sectors, it would be preferable to address these issues directly (Engel et al., 2008). PES is likely to work best in a situation of secure property rights to forest lands and requires some basic quality of governance. This also holds, however, for other types of conservation policies.

6.5 Governance and readiness

Participating in an international REDD mechanism and setting up an effective and efficient local incentive system (whether through PES or other measures), is only possible if basic institutional prerequisites are satisfied. These include, for example, a system of secure and well-defined property rights over forest lands, the capacity to quantify forest inventories and assess future land use trends and related carbon flows, a functioning legal system, the capacity to monitor and enforce existing rules and regula-

tions, and the political will to establish new institutions for forest conservation.

The FCPF explicitly aims to help countries build up the necessary capacity for participating in a REDD mechanism. About a third of the FCPF funding is earmarked to a so-called ‘readiness fund’, which would: (i) help interested developing countries to arrive at a credible estimate of their national forest carbon stocks and sources of forest emissions; (ii) assist in defining their reference scenario based on past emission rates for future emissions estimates; (iii) offer technical assistance in calculating opportunity costs of possible REDD interventions; and (iv) designing an adapted REDD strategy that takes into account country priorities and constraints (World Bank Carbon Finance Unit, 2008). Such an approach appears promising to facilitate participation of least developed countries in a future REDD mechanism. Another approach is the establishment of bilateral forest partnerships between an Annex I Party and a developing country (Dutschke and Wolf, 2007).

While capacity-building is necessary, it should be acknowledged that improvements in governance take time. In the meantime, prospective landowners, whether local communities, government agencies or firms, are likely to continue to claim *de facto* (and sometimes *de jure*) property rights in remote and poorly-governed forest areas. Could such speculative behaviour, typically made in anticipation of earning future rents from the land, also occur in the context of a local REDD payments mechanism? And if so, would it matter? We might expect similar rent-seeking behaviour, although with a system of conditional payments, the ‘new’ forest owners would have incentives not to convert forest. They may even be expected to proactively protect it. REDD payments could then potentially have a positive impact on the environment, particularly where there are weak, endogenous property rights (Engel and Palmer, 2008). Adding carbon values to landowners’ value of the standing forest may increase their ability to protect their *de facto* property rights against intrusion. Although this would to some extent deal with the open access problem of forests, there could be distributional problems if richer actors colonise forest areas at the expense of poorer ones. A nationally-administered, carefully-targeted payments scheme could be one way around this problem (see Moutinho et al., 2009; Hall, 2008).

7 Conclusions

There appears to be a strong case for including REDD in a global climate change mitigation strategy post-Kyoto. Significant progress has been made in addressing previous concerns to such an inclusion. It is now time to synthesize approaches and develop an integrated REDD mechanism. The success of REDD will depend on the ability to show that it can be done. The establishment of the FCPF as a prototype for REDD measures as well as other current pilot activities have an important role to play in this regard. In doing so, it will be crucial that these initiatives incorporate the lessons from recent studies highlighting the complexities and weaknesses of existing forest conservation policies. Upscaling policies such as PES without improving on scheme additionality and cost-effectiveness could undermine the success of a performance-based incentive payment system for REDD services and raise costs of REDD beyond expectations.

In focusing on REDD as a potential strategy for mitigating climate change, this paper has neglected some key elements of the climate change policy debate. First, adaptation strategies have been ignored. It is clear that neither adaptation nor mitigation alone will avoid climate change impacts (IPPC, 2007b), and that forests play a crucial role in adaptation as well. Second, while potential mechanisms for including REDD in an international climate framework have been considered, the practical and legal arguments, for example, of whether to include REDD in an extension to the Kyoto Protocol or to create an entirely new Protocol

altogether were not (see Forner et al., 2006; Gupta et al., 2007). Related to this, the international political economy of REDD inclusion was only briefly touched upon when discussing the possible preferences of different nation states and the political trade-offs being made at the international level in fora such as the UN and G8. For example, recent US legislation considers a potentially important role for REDD and other international forest carbon offsets in domestic climate policy¹⁴.

REDD should, however, be viewed through a prism of scarcity and trade-offs between competing uses for the world's resources. With the world's population forecast to reach 7-11 billion by 2050 (United Nations, 2004), the global demand for energy and food will continue to rise in the coming decades. Ultimately, decisions over the allocation of natural resources will probably be political ones. At the very least, allocations based on economic criteria will be substantially affected by political forces. In this context, the introduction of REDD, or at the minimum, RED, should be seen as an opportunity to reverse deforestation trends and capture forest carbon values, but only as one, perhaps particularly cost-effective way of mitigating climate change. For it to work, it must remain competitive with other land uses. Other mitigation options also require further opportunities for development and implementation; avoided deforestation should not be allowed to stunt investment in other mitigation technologies and economic sectors.

References

- Alix-Garcia, J., de Janvry, A., and Sadoulet, E. (2009) 'The role of risk in targeting payments for environmental services', in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Baumert, K., Herzog, T. and Pershing, J. (2005) *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*, Washington: World Resources Institute (WRI).
- Bulte, E. and Engel, S. (2006) 'Conservation of tropical forests: addressing market failure', in R. López and M. Toman (eds.) *Economic Development and Environmental Sustainability*, Oxford: Oxford University Press.
- Brown, S., Sathaye, J., Cannell, M. and Kauppi, P. (1996) 'Management of forests for mitigation of greenhouse gas emissions', in R.T. Watson, M.C. Zinyowera and R.H. Moss (eds) *Climate Change 1995. Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press.
- CIFOR (2008) *CIFOR's Sven Wunder Discusses How REDD Can Learn From PES*, [Online] Available at: http://www.cifor.cgiar.org/Highlights/redd_interview.htm [accessed 30 July 2008].
- Chomitz, K.M., Buys, P., De Luca, G., Thomas, T.S. and Wertz-Kanounnikoff, S. (2006) *At Loggerheads? Agricultural Expansion, Poverty Reduction and Environment in the Tropical Forests*, World Bank Policy Research Report, Development Research Group, Washington: World Bank.
- Dutschke, M. (2008) *Simply REDD? Konzeptionen, Modelle, Vorschläge zur Emissionsverringderung aus Entwaldung und Walddegradierung*, Paper presented at the Workshop *Wald und Klima*, GTZ Eschborn, Germany, February 12, 2008.
- Dutschke, M. and Wolf, R. (2007) *Reducing Emissions from Deforestation in Developing Countries. The Way Forward*, Climate Protection Programme, Federal Ministry for Cooperation and Development (GTZ), Eschborn, Germany: GTZ.
- Ebeling, J. and Yasué, M. (2008) 'Generating carbon finance through avoided deforestation and its potential to create climatic, conservation and human development benefits', *Philosophical Transactions of the Royal Society B*, 363: 1917–24.
- Economist (2008) *Paying for the Forest*, August 9, London: The Economist.
- Engel, S., Wünscher, T., and Wunder, S. (2009) 'Increasing the efficiency of forest conservation: the case of payments for environmental services in Costa Rica', in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Engel, S. and Palmer, C. (2008) 'Payments for environmental services as an alternative to logging under weak property rights: The case of Indonesia', *Ecological Economics*, 65(4): 799–809.
- Engel, S., Pagiola, S. and S. Wunder (2008) 'Designing payments for environmental services in theory and practice – an overview of the issues', *Ecological Economics*, 65 (4): 663–74.
- FAO (Food and Agriculture Organization of the United Nations) (2001) *Global Forest Resources Assessment 2000*, Rome: FAO.

- FAO (Food and Agriculture Organization of the United Nations) (2006) *Global Forest Resources Assessment 2005*, Rome: FAO.
- Fearnside, P. (2001) 'Saving tropical forests as a global warming countermeasure: an issue that divides the environment movement', *Ecological Economics*, 39(2): 167–84.
- Ferraro, P.J. and Kiss, A. (2002) 'Direct payments to conserve biodiversity', *Science*, 298 (5599): 1718–9.
- Forner, C., Blaser, J., Jotzo, F. and Robledo, C. (2006) 'Keeping the forest for the climate's sake: avoiding deforestation in developing countries under the UNFCCC', *Climate Policy*, 6(3): 275–94.
- G8 (Group of Eight) (2008) *Summary of the Hokkaido Toyako Summit*, [Online] Available at: <http://www.g8summit.go.jp/eng/news/summary.html> [accessed 3 August 2008].
- Geist, H. and Lambin, E. (2002) 'Proximate causes and underlying driving forces of tropical deforestation', *BioScience*, 52(2): 143–50.
- Grieg-Gran, M. (2009) 'The costs of avoided deforestation as a climate change mitigation option', in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Gullison, R.E., Frumhoff, P.C., Canadell, J.G., Field, C.B., Nepstad, D.C., Hayhoe, K., Avissar, R., Curran, L.M., Friedlingstein, P., Jones, C.D. and Nobre, C. (2007) 'Tropical Forests and Climate Policy', *Science*, 316(5827): 985–86.
- Gupta, S., Tirpak, D.A., Burger, N., Gupta, J., Hoehne, N., Boncheva, A.I., Kanoan, G.M., Kolstad, C., Kruger, A., Michaelowa, A., Murase, S., Pershing, J., Saijo, T. and Sari, A. (2007) 'Policies, instruments and co-operative arrangements', in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave and L.A. Meyer (eds.) *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.
- Hall, A. (2008) 'Better RED than dead: paying the people for environmental services in Amazonia', *Philosophical Transactions of the Royal Society B*, 363: 1925–32.
- Harris, N. L., Petrova, S. and Brown, S. (2009) 'A scalable approach for setting avoided deforestation baselines', in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Houghton, R.A. (2005) 'Tropical deforestation as a source of greenhouse gas emissions', in P. Moutinho and S. Schwartzman (eds.) *Tropical Deforestation and Climate Change*, Belém, Brazil: Amazon Institute for Environmental Research (IPAM), and Washington: Environmental Defense.
- IPCC (Intergovernmental Panel on Climate Change) (2001) *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change) (2007a) *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Geneva: IPCC.
- IPCC (Intergovernmental Panel on Climate Change) (2007b) *Climate Change 2007: Synthesis Report Summary for Policymakers, Intergovernmental Panel on Climate Change*. Fourth Assessment Report. Cambridge and New York: Cambridge University Press.
- Johns, T. and Schlamadinger, B. (2009) 'International policy and institutional barriers to reducing emissions from deforestation and degradation in developing countries', in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Kremen, C., Niles, J., Dalton, M., Daily, G., Ehrlich, P., Fay, J., Grewal, D. and Guillery, R. (2000) 'Economic incentives for rain forest conservation across scales', *Science*, 288 (5472): 1828–32.
- Jakarta Post (2008) 'RI to begin forest carbon projects', August 4 2008 [Online] Available at: <http://www.thejakartapost.com/news/2008/06/17/ri-begin-forest-carbon-projects.html> [accessed 4 August 2008].

- Kaimowitz, D. and Angelsen, A. (1998) *Economic Models of Tropical Deforestation: A Review*, Bogor: Center for International Forestry Research (CIFOR).
- Laurance, W.F. (2007) ‘A new initiative to use carbon trading for tropical forest conservation’, *Biotropica*, 39(1): 20–4.
- Lecocq, F. and Chomitz, K. (2001) *Optimal Use of Carbon Sequestration in a Global Climate Change Strategy: is there a Wooden Bridge to a Clean Energy Future?* Washington D.C.: World Bank.
- Michaelowa, A. and Dutschke, M. (2009) ‘Will credits from avoided deforestation in developing countries jeopardize the balance of the carbon market?’ in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Moutinho, P., Cenamo, M., and Moreira, P. (2009) ‘Reducing carbon emissions by slowing deforestation: REDD initiatives in Brazil’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Moutinho, P. and Schwartzman, S. (eds) (2005) *Tropical Deforestation and Climate Change*, Belém: Amazon Institute for Environmental Research (IPAM) and Washington: Environmental Defense.
- Murdiyarmo, D. and Herawati, H. (eds) (2005) *Carbon Forestry: Who will Benefit? Proceedings of Workshop on Carbon Sequestration and Sustainable Livelihoods*, Bogor: Center for International Forestry Research (CIFOR).
- Murray, B. (2009) ‘Leakage from an avoided deforestation compensation policy: concepts, empirical evidence, and corrective policy options’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Nepstad, D., Stickler, C., Soares-Filho, B. and Merry, F. (2008) ‘Interactions among Amazon land use, forests and climate: prospects for a near-term forest tipping point’, *Philosophical Transactions of the Royal Society B*, 363: 1937–46.
- Pacala, S. and Socolow, R. (2004) ‘Stabilization wedges: solving the climate problem for the next 50 years with current technologies’, *Science*, 305 (5686): 968–72.
- Palmer, C., and Engel, S. (eds) (2009) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Palmer, C., and Obidzinski, K. (2009) ‘Choosing avoided deforestation baselines in the context of government failure: the case of Indonesia’s plantations policy’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Pearce, D.W., Putz, F. and Vanclay J.K. (2002) ‘Is sustainable forestry economically possible?’ in D.W. Pearce, C. Pearce and C. Palmer (eds.) *Valuing the Environment in Developing Countries: Case Studies*, Cheltenham: Edward Elgar.
- Pfaff, A. and Robalino, J. (2009) ‘Human choices and policies’ impacts on ecosystem services: Improving evaluations of payment and park effects on conservation and carbon’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Rametsteiner, E., Obersteiner, M., Kindermann, G. and Sohngen, B. (2009) ‘Economics of avoiding deforestation’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Richards, K., and Stokes, C. (2004) ‘A review of forest carbon sequestration cost studies: a dozen years of research’, *Climatic Change*, 63(1–2): 1–48.
- Schneider, S. (1998) ‘Kyoto Protocol: the unfinished agenda. An editorial essay’, *Climatic Change*, 39(1): 1–21.
- Sohngen, B. (2009) ‘Assessing the economic potential for reducing deforestation in developing countries’, in C. Palmer and S. Engel (eds) *Avoided Deforestation: Prospects for Mitigating Climate Change*, Oxford: Routledge.
- Stern, N. (2007) *The Economics of Climate Change: the Stern Review*, Cambridge: Cambridge University Press.
- Strassburg, B., Turner, K., Fisher, B., Schaeffer, R. and Lovett, A. (2008) *An Empirically-derived Mechanism of Combined Incentives to Reduce Emissions from Deforestation*, CSERGE Working Paper ECM 08-01, Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia.

- Streck, C., O'Sullivan, R., Janson-Smith, T. and Tarasofsky, R. (eds) (2008) *Climate Change and Forests Emerging Policy and Market Opportunities*, Washington D.C.: Brookings Institution Press.
- Tavoni, M., Sohngen, B. and Bosetti, V. (2007) 'Forestry and the carbon market response to stabilize climate', *Energy Policy*, 35(11): 5346–53.
- UNFCCC (United Nations Framework Convention on Climate Change) (2007) *Decision-/CP.13 Bali Action Plan*, [Online] Available at: http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf [accessed 15 June 2008].
- UNFCCC (United Nations Framework Convention on Climate Change) (2008) *Kyoto Protocol Status of Ratification*, [Online] Available at: http://unfccc.int/files/Kyoto_protocol/status_of_ratification/application/pdf/kp_ratification.pdf [accessed 1 August 2008].
- United Nations (2004) 'World population in 2300', *Proceedings of the United Nations Expert Meeting on World Population in 2300*, New York: United Nations.
- World Bank Carbon Finance Unit (2008) *About Forest Carbon Partnership Facility (FCPF)*, Washington: World Bank. [Online] Available at: <http://carbonfinance.org/Router.cfm?Page=FCPF&ft>About> [accessed 20 July 2008].
- Wunder, S. (2005) *Payments for Environmental Services: Some Nuts and Bolts*, CIFOR Occasional Paper 42, Bogor: Center for International Forestry Research (CIFOR).
- Wunder, S., Engel, S., and Pagiola, S. (2008) 'Taking stock: a comparative analysis of payments for environmental services programs in developed and developing countries', *Ecological Economics*, 65(4): 834–52.

Endnotes

¹ Much of the material in this paper is taken from Palmer and Engel (2009), with the publisher's permission. An earlier version of Engel and Palmer (2009) benefited from comments and suggestions from Ken Chomitz, Michael Dutschke, Brian Murray and Sven Wunder.

² Authors are listed alphabetically

³ 'Avoided deforestation' is otherwise known as Reducing Emissions from Deforestation (RED). Inclusion of forest degradation extends this definition to REDD. Both RED/avoided deforestation and REDD are covered in Palmer and Engel (2009) depending on the topic under discussion.

⁴ For example, a recent overview of the issues can be seen in Dutschke and Wolf (2007). A discussion of avoided deforestation in the context of climate change and deforestation can be seen in the relevant chapters of Stern (2007) and Chomitz et al. (2006), respectively. Policy-related issues alongside the legal and technical considerations of avoided deforestation are covered by Moutinho and Schwartzman (2005). See also Murdiyarso and Herawati (2005) for chapters relating to livelihood issues, in addition to those focusing on the CDM and carbon sequestration from a bioscience perspective. International policy issues and how REDD might fit into climate policy from a practical perspective are covered by Streck et al. (2008).

⁵ For example, at the COP-11 in Montreal in 2005, a coalition of 15 rainforest nations led by Papua New Guinea and Costa Rica floated a proposal to allow CDM-type credits, bought by industrialized nations, in exchange for reducing deforestation. See: <http://www.rainforestcoalition.org/eng/>.

⁶ The importance of international collaboration in solving the global collective action in climate change policy is reviewed in Gupta et al. (2007). The relative merits of Kyoto and alternative arrangements for international cooperation can be seen in Forner et al. (2006).

⁷ Note, however, that the price of avoided deforestation as a mitigation option will be determined by the marginal cost and not the average cost. We expect there to be differences between the two depending on the shape of the marginal cost curve.

⁸ Existing studies are too numerous to list here. For a good overview, see Richards and Stokes (2004).

⁹ The Amazon Fund was launched by the Brazilian government in July 2008 with an initial donation of US\$100 million from the Norwegian government (Economist, 2008). See: <http://www.amazonfund.org/>.

¹⁰ A recent comparison of 15 PES or 'PES-like' systems around the world favourably reviews their conservation outcomes and efficiency, thus providing a number of possible models for REDD (see Wunder et al., 2008). Nonetheless, PES, despite being a focus in this volume, is not a panacea for dealing with all environmental problems (see Engel et al., 2008).

¹¹ Alternatively, and instead of making direct payments to potential deforesters (assuming that they can be identified in the first place), any transfers received by a particular country say from an international fund like the FCPF could simply be invested in systems that discourage deforestation behaviour, e.g. for monitoring and enforcement.

¹² In order to stabilize the CO₂ concentration in the atmosphere at around 400-450 ppm (IPPC, 2007b).

¹³ A time delay in emissions reduced by abatement measures could result in permanent climate benefits if the cumulative atmospheric concentrations of GHG are lower at any future point in time (Ebeling and Yasué, 2008).

¹⁴ The Lieberman-Warner Climate Security Act of 2008. See: www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf.



ETH Zurich
Institute for Environmental Decisions IED
WEH G
CH-8092 Zurich
SWITZERLAND

Phone +41 44 632 47 18
Fax +41 44 632 10 42
URL <http://www.ied.ethz.ch>