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Using PES to implement REDD

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Abstract
Payments for Environmental Services (PES) are one of the instruments that countries might use to try to reduce deforestation, and hence receive payments for Reduced Emissions from Deforestation and forest Degradation (REDD). This paper discusses four aspects related to the use of PES as an instrument to implement an avoided deforestation program, based on a review of PES experiences in Latin America. First, the paper discusses the applicability of PES in the context of REDD. PES is only one of the instruments that can be used to reduce deforestation. Some types of deforestation problems may not be amenable to the use of PES, while others might be better addressed with other instruments. Second, the paper examines the evidence on the effectiveness of PES as a tool to reduce deforestation. Although it seems intuitive to think that paying for forest conservation would reduce deforestation, the available evidence from existing PES programs is mixed. Third, the paper discusses several welfare considerations arising from the possible use of PES as a tool to reduce deforestation. That REDD be implemented in ways that do not harm the welfare of forest-dependent peoples has been an important part of the debate.

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Cover photo
Forest areas cleared for pasture in Nicaragua (Stefano Pagiola).

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Using PES to implement REDD

Stefano Pagiola

1. Introduction

Deforestation is estimated to contribute about 15 percent of total emissions of greenhouse gases (GHGs).[1] Reducing emissions from deforestation and forest degradation in developing countries (REDD) could thus make a significant contribution to mitigating global climate change. Moreover, many estimates have shown that REDD could help reduce emissions at a significantly lower costs than many other mitigation options. A successful REDD system would contribute to mitigating global climate change by helping to significantly reduce deforestation and forest degradation worldwide, while contributing to sustainable development and to enhancing the welfare of local populations.

The Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed in December 2007 in Bali to explore policies and financial incentives that could be implemented to encourage REDD after 2012. This was confirmed by the negotiations in Copenhagen in December 2009, at the Oslo Climate and Forests Conference in May 2010, and at the Cancun Conference of Parties in December 2010. Pending such an international agreement, several efforts to pilot the development of REDD programs are underway, including the Forest Carbon Partnership Facility (FCPF) established by the World Bank; the UN-REDD Programme launched by the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP); the Forest Investment Program (FIP) set up as part of the Climate Investment Funds (CIF) jointly managed by the multilateral development banks; and several initiatives by individual countries, such as Norway's Climate and Forest Initiative, Australia's International Forest Carbon Initiative, and the Congo Basin Forest Fund established by the United Kingdom and Norway.

Countries envisaging participating in a REDD program face numerous challenges. Among these, critically, is the need to develop strategies that would effectively reduce deforestation. Although much remains to be decided about how REDD will work, practically all proposals call for REDD payments to be conditional: countries would only receive payments for actual reductions in deforestation and forest degradation and for increases or stabilizations in forest carbon stocks.[2]

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[1] For a review of the most recent data on emissions from deforestation, see van der Werf and others (2009). Earlier estimates placed emissions from deforestation at around 20 percent of total emissions.

[2] The REDD concept has continually evolved. It initially focused on avoided deforestation ('RED'), then added forest degradation ('REDD'), then also came to include conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks ('REDD+'). It is currently taken to include efforts to 'slow, halt, and reverse forest loss.'

Countries thus need effective measures to reduce emissions or increase or stabilize stocks if they hope to receive REDD funds.

Programs of Payments for Environmental Services (PES) have attracted considerable attention as a conservation tool in recent years and are likely to play an important role in many REDD strategies. PES is a market-based approach to conservation financing based on the twin principles that those who benefit from environmental services (such as users of clean water) should pay for them, and that those who contribute to generating these services (such as upstream land users) should be compensated for providing them (Wunder, 2005; Pagiola and Platais, 2007; Engel and others, 2008; Wunder and others, 2008). That participation by service providers be voluntary and that payments be conditional are two defining characteristics of PES programs. REDD itself can be seen as a form of international PES, in which countries are compensated for the carbon sequestration services they provide to the global community. Within a given country, PES is one of the instruments that countries might use to try to reduce deforestation, which would enable them to receive REDD payments. The focus in this paper is on this latter use of PES.

This paper discusses four aspects related to the use of PES as an instrument to implement a REDD program, based on a review of PES experiences in Latin America, which are briefly summarized in section 2. First, the paper discusses the applicability of PES in the context of REDD (section 3). PES is only one of the instruments that can be used to reduce deforestation. Some types of deforestation problems may not be amenable to the use of PES, while others might be better addressed with other instruments. Second, the paper examines the evidence on the effectiveness and efficiency of PES as a tool to reduce deforestation (section 4). Although it seems intuitive to think that paying for forest conservation would reduce deforestation, the available evidence from existing PES programs is mixed. Third, the paper discusses several welfare considerations arising from the possible use of PES as a tool to reduce deforestation (section 5). That REDD be implemented in ways that do not harm the welfare of forest-dependent peoples has been an important part of the debate.

2. Experience with PES in Latin America

In the last decade, Latin America has accumulated substantial experience with the use of PES. A recent review identified almost 80 active PES programs in 18 countries in Latin America and the Caribbean, with many more being proposed (Camhi and Pagiola, 2010). Almost all these programs focus their efforts on forests, and most focus on conserving existing forests.

Two main types of PES programs can be identified (Pagiola and Platais, 2007; Engel and others, 2008). A few countries have established national, g*overnment-financed* PES programs. Costa Rica led the way in 1997 with its PSA program, which aims to preserve the many benefits that forests provide by paying landholders who maintain forest cover on their land (Pagiola, 2008). Mexico followed in 2003, with its PSAH program, later renamed PSAB (Muñoz and others, 2008). Ecuador established the

Socio Bosque program in 2008. In Brazil, the state of Amazonas established the *Bolsa Floresta* program in 2008; several other states, including São Paulo and Espírito Santo, are also establishing PES programs.[3] National programs typically cover substantial areas: Costa Rica's PSA program currently has about 300,000 ha of forest enrolled, while Mexico's PSAB program covers 1.9 million ha.

The vast majority of cases are of *user-financed* programs, in which payments to service providers depend on payments made by service users. Most are watershed-scale programs financed by water users, such as domestic water supply systems (Echavarría, 2002a; Wunder and Albán, 2008; Barrantes and Gámez, 2007), hydroelectric power producers (Rojas and Aylward, 2002), irrigation systems (Echavarría, 2002b), and others. There have also been many carbon sequestration projects financed by carbon buyers, either through the Clean Development Mechanism (CDM) or through the voluntary market (Hamilton and others, 2009, 2010). A few programs have focused on biodiversity conservation, with financing from donors such as the Global Environment Facility (GEF) or conservation groups such as the World Wildlife Fund (WWF) (Missrie and Nelson, 2005; Pagiola and others, 2007). User-financed programs tend to be much more narrowly targeted and thus cover much smaller areas.[4]

PES requires a secure long-term source of financing to work effectively, as in most cases payments to providers need to be made for long periods—often indefinitely. The inability or unwillingness of most governments to devote budgetary resources to such programs has limited the number of national-scale PES programs to date, but REDD financing would allow a substantial expansion of such programs. The focus in this paper is on such national programs, as most proposed REDD mechanisms would work through national governments. REDD funds could also finance sub-national PES mechanisms if sub-national measures are ultimately accepted under REDD rules (from example, under the 'nested' approach proposed by Pedroni and others, 2007), or if countries choose to support sub-national PES mechanisms as part of their REDD strategies.[5] Most of the discussion here would be equally applicable to sub-national programs, but such programs would also face additional concerns about the potential for leakage of deforestation to other areas.

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[3] Because of the size of Brazilian states, we consider their PES programs here as equivalent to national programs.

[4] User-financed PES programs are considered most likely to be efficient as service users provide not only financing but also information on what services are most valuable, and have a strong incentive to ensure that payments are used effectively. Conversely, government-financed programs typically lack these characteristics and so are less likely to be efficient; government-financed programs are also much more susceptible to political interference (Pagiola and Platais, 2007; Wunder and others, 2008).

[5] It should be noted that even 'national' programs limit their activities to specified priority areas, and so are effectively sub-national in scope.

3. Applicability of PES

PES is intended to address situations in which land uses provide positive externalities (Pagiola and Platais, 2007; Engel and others, 2008). As carbon sequestration is a positive externality, it might seem that PES would always be an appropriate instrument. This is not the case, however, for several reasons. First, in some cases deforestation is driven by causes other than externalities. Second, even where PES is an appropriate instrument, it may not be possible to implement it. Third, even if PES is appropriate and feasible, there may be other instruments that are simpler to implement.

Deforestation has many possible causes, not all of which are amenable to PES as a solution. The literature on the cause of deforestation is extensive, and has identified a wide range of factors that can contribute to forest loss, directly or indirectly (Angelsen and Kaimowitz, 1999; Geist and Lambin, 2002).

Figure 1 uses a simple von Thunen model to illustrate tradeoffs in a forest area. The country's forest area, F, is shown on the horizontal axis, measured from right to left, with the areas closer to markets shown on the left. Line RF shows returns to forests, as they are perceived by landholders; these returns are assumed to be higher close to markets, as transport costs are lower, making sales of timber and non-timber products more profitable. Line RA shows returns for agriculture over the same area.[6] These are also assumed to be highest in areas closer to markets. In fact, they are assumed to be much higher than returns to forest in the areas closest to markets. Under these conditions, one would expect deforestation to occur up to the point at which returns to forest exceed returns to agriculture.[7] Thus under a business as usual scenario, the forest area would be reduced from F to F_{BAU}.[8] This deceptively simple formulation captures a wide range of factors that analysts have identified as leading to deforestation. Many drivers of deforestation act by either increasing return to agriculture or other alternatives to forest (moving up the RA line), or by reducing returns to forests (moving down the RF line). Population growth, for example, results in higher returns to agriculture through increased demand for food. Income growth, which increases per capita food consumption and shifts consumption to foods such as meat which require more land to produce, acts in the same way. Either movement would result in a lower equilibrium level of forest (F_{BAU} would move to the right).

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[6] For ease of exposition in what follows, we assume here that on-site returns to forest and to agriculture are the same from the farmers' and the country's perspectives.

[7] Indeed, that deforestation tends to decline with distance from markets, all other things equal, is a consistent result of spatially-explicit models of deforestation (Chomitz and Gray, 1996; Nelson and Hellerstein, 1997; Pfaff, 1999; Cropper and others, 2001).

[8] This model could easily be extended to include forest degradation (the second 'D' in REDD) by adding a separate line RL showing returns to logging or other activities that degrade forests. The forest area would then be partitioned into three portions: (1) that which would be entirely deforested, where RA>RL or RF; (2) that which would be degraded, where RL>RA or RF; and (3) that which would remain as intact forest, where RF>RA or RL.

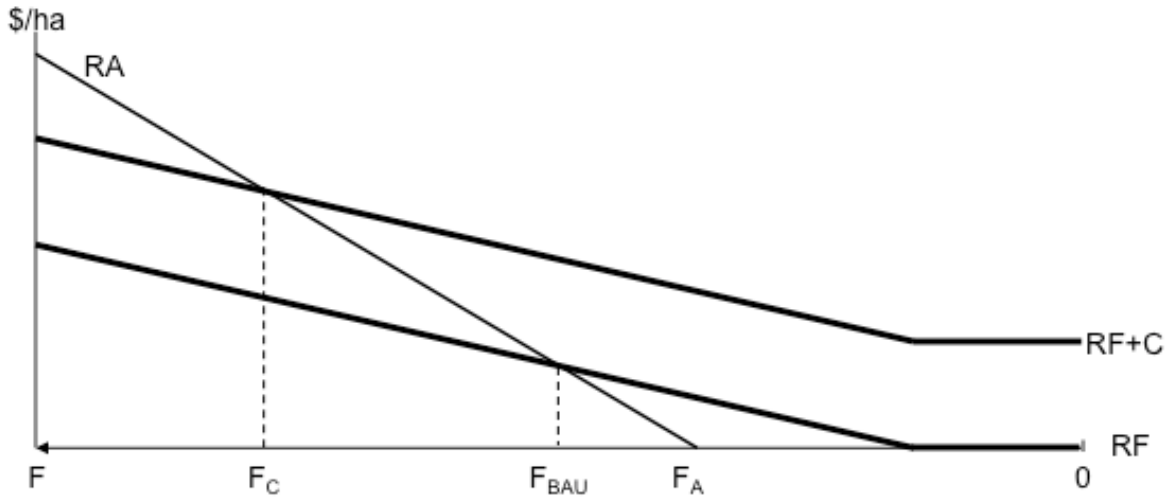

Figure 1: Returns to forest and to agriculture

That the resulting deforestation is inefficient from society's perspective is shown by line RF+C. The returns perceived by landholders only include the on-site benefits that they themselves can capture, such as returns from logging or from harvesting non-timber products. They do not include off-site benefits such as carbon sequestration, watershed protection, or biodiversity conservation. Because of its low value *to them*, landholders thus convert much more forest than would be socially optimal. As Chomitz and others (2007:195) note, "farmers are destroying a $10,000 asset to create one worth $200." If the carbon sequestration benefits of forests could be fully incorporated, the returns to forests as perceived by landholders would increase to RF+C, and the equilibrium forest area would increase to F_C.[9] That is, expected deforestation would fall from ($F-F_{BAU}$) to ($F-F_C$). Numerous studies have shown that even at relatively low carbon prices, the optimal level of deforestation would be substantially lower (Grieg-Gran, 2006; Börner and Wunder, 2008; Kindermann and others, 2008).

The logic for a PES program in these conditions seems compelling. By providing a payment to preserve forests, returns to forests as perceived by landholders would rise, and deforestation would fall.[10]

Higher returns to alternative land uses, however, are not the only reason that forests are cut down. In many cases, insecure tenure in forest areas is a major reason for the loss and degradation of forests (Brown and Pearce, 1994; Angelsen and

[9] Likewise, incorporating the value of other externalities, such as watershed protection or biodiversity conservation, would further increase the value of forests and thus reduce deforestation. Whereas all forests sequester carbon, however, the degree to which individual forests provide watershed protection or biodiversity conservation varies substantially, making a simple von Thunen model poorly suited to understanding the issues involved.

[10] As the value of conserving carbon in a given forest area can be estimated relatively precisely, for a given price of carbon, the payment could in fact be made to closely approximate the social value of sequestration. In contrast, a regulatory approach would necessarily be much blunter.

Kaimowitz, 1999).[11] Landholders may not have the authority to manage forests, because the forests belong to nobody or to the state (which amounts to the same if the state is unable to enforce management rules) and thus tend to neglect even the on-site impacts of their management decisions (Ostrom, 2003). Araujo and others (2009), for example, find that insecure tenure in the Brazilian Amazon reduces the present value of forests and induces land holders to convert forest into agricultural and pasture lands. Because of insecure tenure, deforestation may in fact extend into areas where returns to forest are higher than those to alternative land uses. Returns to agricultural land uses can often be wholly appropriated by those who clear land, unlike returns to forest. In areas with insecure tenure, deforesting land may also serve to assert possession. In many countries of Latin America, clearing land was often considered to be 'improving' it and gave those doing so possession rights which could eventually be converted to outright ownership (Southgate, 1990; Schneider, 1993; Araujo and others, 2009). In such cases, deforestation might occur even in areas where RF>RA. The final level of forest cover, therefore, could be as low as FA.[12]

As long as tenure remains insecure, PES programs are very difficult, if not impossible, to implement. PES requires reasonably secure land tenure.[13] PES are payments for land use, and if the effective managers of a given area cannot be reliably identified, developing payment arrangements may not be possible. Indeed, PES in this case might actually be counterproductive. Offering payments in areas with insecure tenure could increase the attractiveness of invading these areas, leading to a rush to grab land with significant adverse consequences for forest-dependent peoples in these areas and for forests themselves.

The difficulty of implementing PES programs in areas with insecure tenure is a significant one, as in many countries these are precisely the areas where most active deforestation is taking place (Araujo and others, 2009; Börner and Wunder, 2008). In such areas, other measures may be needed. Alternatively, PES could be offered once the tenure situation has been clarified, but this process would have to be handled very carefully.

It is important to note here that while clarifying tenure rights is often a precondition for reducing deforestation, it is not always sufficient. In areas where

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[11] The issue of tenure in REDD has been the subject of intense debate. See, among many others, Sunderlin and others (2009) and Cotula and Mayers (2009). The focus here is only on those aspects that pertain directly to the potential for implementation of a REDD-financed PES program to reduce deforestation.

[12] It is unlikely to fall below FA, however, as there would be no incentive to clear land which has no value under alternative land uses.

[13] Note that this does not imply that PES can only work where landholders have land titles. Many current PES programs operate in areas where most landholders only have possession rights (Pagiola and Platais, 2007). Costa Rica's PSA program requires participants to have land titles, but this requirement comes from broader restrictions on how public funding may be used in that country, and not from the PSA program itself. Significantly, PES contracts within the PSA program that are not financed with public funding (for example, contracts financed with funding from individual water users) are not subject to this restriction (Pagiola, 2008).

returns to alternative land uses exceed returns to forest (RA>RF), improving tenure security would not result in forests being conserved.

That PES cannot be used in areas with insecure tenure, though a significant limitation, does not entirely preclude its use. First, in many countries the area of forest that does have reasonably secure tenure is far from small, and also needs to be conserved. Indeed, if measures—of whatever nature—to reduce deforestation in areas with insecure tenure prove effective, there will likely be increased pressure on remaining forests in other areas. A PES program could help avert this threat.

Second, PES could also play a useful role in areas in which property rights exist but are at present weakly enforced. In many countries, for example, indigenous groups nominally control large areas, but they are often unable to prevent settlement, logging, and other threats (Chomitz and others, 2007; RRI, 2012).[14] In such areas, Engel and Palmer (2008) show that PES can tilt the balance in the favor of indigenous groups. In Costa Rica, the PSA program has been shown to improve tenure security, as it provides a form of official recognition of the landholders' control over a given area (Porras and others, 2007). There have been many examples of PES programs working successfully with indigenous groups, notably in Costa Rica (Borge and Martínez, 2009) and Mexico. Implementing PES programs in such areas, however, requires extensive prior consultations. The potential rewards of meeting this challenge are substantial, however, as in addition to reducing forest loss they could also generate important social benefits for these groups. Participation in Costa Rica's PSA program, for example, has had a strong positive impact on many indigenous groups, not only in terms of income (they receive substantially more resources from PES payments than from all other government programs combined) but also in terms of administrative capacity and social cohesion (Borge and Martínez, 2007).

In areas where forest returns are higher than agricultural returns (RF>RA), PES is also unnecessary. If forest managers could be confident of receiving the returns from maintaining forests, they would already have sufficient incentive to preserve them, even in the absence of additional payments. Indeed, a growing literature demonstrates that giving local communities secure rights over forests can have a substantial positive impact on forest management (Porter-Bolland and others, 2012). Note that this argument only applies where forest returns exceed those to alternative land uses. When this is not the case (that is, where RA>RF), clarifying property rights would not result in forest conservation.

Even in areas with secure tenure, PES may not be the first-best solution. In many cases, there may be opportunities to improve returns to forests, either by removing constraints that limit them or by investments that increase them. Both these approaches would move up the RF line and thus increase the equilibrium level of forest. If deforestation is associated with a lack of awareness or information about

[14] Recent evidence shows that many indigenous areas have experienced lower rates of deforestation than similar forests outside (Nepstad and others, 2006; Chomitz and others, 2007; Stocks and others, 2007).

land use practices that are in the private landholder's own financial interest to adopt (Bulte and Engel, 2006), for example, then education and awareness building are appropriate responses. Similarly, if capital market imperfections prevent landholders from adopting privately profitable technologies or practices that conserve forests, then providing access to credit is the most promising approach (Engel, 2007). Addressing such constraints to the profitability of forests would be desirable even if emissions were not an issue. There have also been many efforts to increase returns to forests, for example through ecocertification (Durst and others, 2006; Damette and Delacote, 2011), ecotourism (Wunder, 1999), improved production of timber and non-timber products (Arnold and Perez, 2001), and other measures. Some of these approaches to increase returns to forests might be more attractive than PES in that they might be achieved by short-term investments rather than requiring long-term efforts, as PES does. Unfortunately, there have been few careful assessments of the extent to which such efforts have succeeded in reducing deforestation.

Deforestation could also be reduced by adopting policies that tend to move the RA curve down. To the extent that this entails removing distortionary policies, the result is win-win: it both reduces inefficiency in the economy and reduces deforestation. Although such distortionary policies are less common than they once were, they are by no means extinct (Anderson, 2010).

A related approach that has often been advocated is to intensify agricultural production in areas that have already been deforested. In Brazil, for example, converting existing extensive pasture to more productive silvopastoral practices could help reduce deforestation by about two-thirds compared to projected levels (de Gouvello, 2010). In terms of Figure 1, the intention here is to rotate the RA line clockwise so that returns are higher on land best suited to agriculture and lower on land less suited. This can be a dangerous strategy, however, as it could result in shifting the RA curve up even in areas still under forest (Angelsen and Kaimowitz, 2001). In terms of reducing deforestation, intensification of agriculture works best when the more intensive production practices cannot be implemented in the forest areas. For example, Shively and Pagiola (2004) show that construction of irrigation in a coastal plain in Palawan, Philippines, reduced deforestation by attracting additional labor from adjacent hillside areas. In this case, extending irrigation into the steeply sloped areas which were still under forest was impossible.

In summary, the applicability of PES as a measure to reduce deforestation is likely to vary substantially across the landscape. Following Chomitz and others (2007), it is useful to distinguish (a) forest-agriculture mosaic-lands, where tenure is generally well defined; (b) frontier and disputed areas, where agriculture is actively converting relatively undisturbed forest and tenure is generally poorly defined; and (c) areas beyond the agricultural frontier where tenure may also be weak, but where threats to forests are very low. Toni (2006) estimated that 25 percent of land in the Brazilian Amazon is in private farms, 35 percent in protected areas and indigenous lands, and

40 percent in public lands.[15] PES is generally likely to be highly applicable in the mosaic-lands, although other measures may be available which may be easier to implement. PES is likely to be difficult to apply in frontier areas, with the possible exception of areas where local groups have property rights which hitherto have been only weakly enforced. PES is largely un-necessary in areas beyond the frontier.[16]

4. Effectiveness and efficiency of PES

If the value of something increases, its supply generally increases. In principle, therefore, increasing the returns to forests should induce a greater supply of forests. At the margin, landowners with forest areas will be less likely to clear it.[17] Thus a PES program could either help avoid deforestation, or help induce (or accelerate) forest regeneration. This effect only occurs, however, in the case of payments received by landholders who would have deforested in the absence of payments. Any payments received by landholders who would not have deforested anyway have no effect on deforestation rates: such payments would not result in any *additionality*.

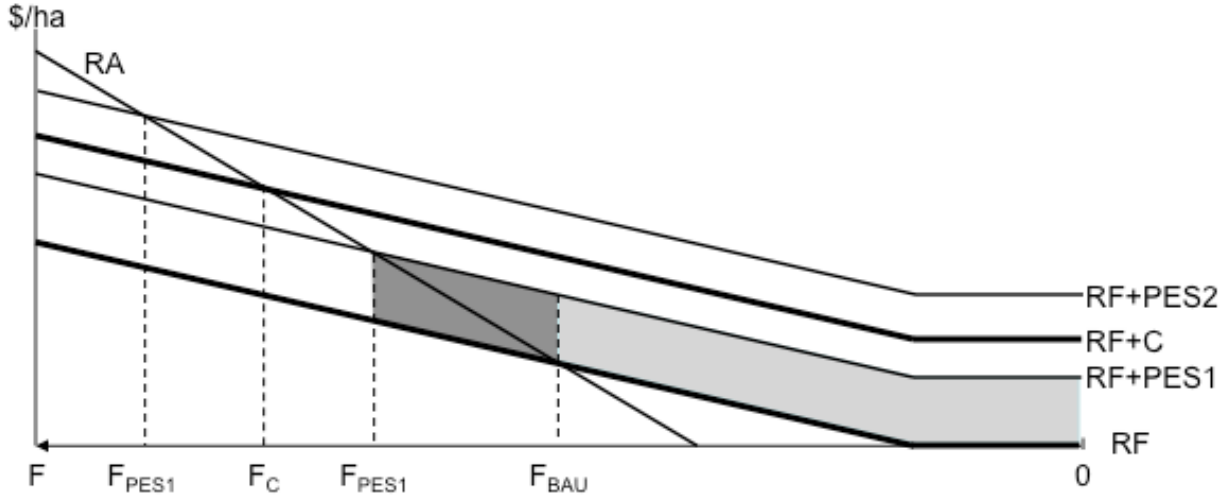

Figure 2: Effectiveness of PES

Figure 2 illustrates why a PES program may not have the desired impact on forests. Suppose a flat payment of PES1 is offered to all landholders who conserve forest on their land, as Costa Rica and Mexico's PES programs do. If the budget were

[15] For the purpose of assessing the possible effect of PES, it would be more interesting figures to know what proportion of the remaining forest areas is in each category.

[16] Note, however, that the frontier will shift over time. It may be desirable to implement a PES program in forest areas beyond the current frontier that have secure tenure. Such a program would only require small payments (as opportunity costs are currently very low), and would lay the groundwork for future efforts when the frontier shifts.

[17] In addition, depending on how the program rules are written, landholders without forest may be more inclined to allow forest to regenerate. Costa Rica's PSA program considers forest which has regenerated for about 5 years to be eligible to participate in its forest protection contract (Pagiola, 2008).

sufficient to enroll all landholders interested in participating, the equilibrium forest area would increase from F_{BAU} to F_{PES1}.[18] In practice, however, many PES programs have had insufficient budget to enroll all those interested in participating, and have had to limit enrolment. The budget of Costa Rica's PSA program generally allows it to enroll about 10 percent of the country's forests at any one time. The program typically receives enrolment applications from about three times as much land as funds allow it to accept (Pagiola, 2008). The program accepts valid applications in the order in which they are received until the budget is exhausted. The budget of Mexico's PSAB program generally allows about 3-4 percent of that country's forests to be enrolled. PSAB assigns points to valid applications based on various criteria, and then accepts the highest-ranked applications until its budget is exhausted. When the budget is insufficient to enroll all forest areas, the effect on deforestation depends on which landholders are ultimately enrolled. Enrolling landholders in the range $F_{PES1}F_{BAU}$ (where RA>RF) would reduce deforestation, while enrolling landholders with forest in the range OF_{BAU} (where RF>RA) would not. Landholders in the latter area, however, have very high incentives to participate, as they would not have deforested even in the absence of PES, and the payment they would receive would be pure net benefit. Conversely, landholders with forest in the range $F_{PES1}F_{BAU}$, where RA>RF, would only conserve forest if they receive payments. If they do participate in the PES program, however, the net benefit they would receive would be less than the full value of the payment. Their incentive to enroll, therefore, is lower than that of landholders who would not have deforested. Because of this incentive effect, a blanket, untargeted PES program can be quite ineffective.

Although studies in Costa Rica have generally found PSA recipients to have higher forest cover than non-recipients (Ortiz and others, 2003; Zbinden and Lee, 2005; Sierra and Russman, 2006), these results may be due to sample selection bias (Sills and others, 2006). Indeed, Ortiz and others (2003) and Miranda and others (2003) both report that many PSA participants stated they would have protected their forest even in the absence of the PSA Program. Formal tests of the extent to which the PSA program has affected forest cover have given mixed results. Tattenbach and others (2006) developed an econometric model of gross deforestation during the period 1996-2000 using district-level data from the Cordillera Volcanica Central Conservation Area (ACCVC). Using their model, they estimated that primary forest cover nationwide in 2005 was about 10 percent greater than it would have been without the PSA Program. A comparison of their estimates of avoided deforestation (108,000 ha) to the area under contract (270,000 ha) suggests that about 38 percent of forest conservation contracts actually resulted in avoided deforestation. This ratio is lowest (13 percent) in areas of low deforestation risk, and highest (47 percent) in areas of high deforestation risk. Sills and others (2008) used a propensity score matching method with farm-level data from Sarapiquí from 1997 to 2000 and found evidence that PSA has encouraged protection of mature native forest. A separate test using nationwide district-level data gave inconclusive results, however. Finally, Pfaff

[18] The closer the value of the payment offered to the value of carbon sequestered, the closer F_{PES1} will be to F_C.

and others (2008) found that the PSA Program is likely to have had a minimal impact on deforestation during the period 1997-1999. It is difficult to compare these results, however, as they apply to different areas, different time periods, different dependent variables, and use different methodologies.

To date, only one assessment of the effect of Mexico's PSAB program on deforestation has been carried out.[19] Alix-Garcia and others (2010) find a small positive effect among participants enrolled in 2004, with considerable heterogeneity across regions and types of properties. As discussed below, the PSAB program has sought to target areas at higher risk of deforestation in recent years, so its effectiveness in reducing deforestation may have increased over time. The other national-scale programs are too recent for their impact on deforestation to be visible yet, though some evidence points to a lower incidence of forest fires in areas covered by Amazonas' *Bolsa Floresta* program (FAS, 2010).

Figure 2 also illustrates another problem that will affect un-targeted PES programs, namely low efficiency from a budgetary perspective. If payments are offered to all landholders that conserve forest, and the budget was sufficient to enroll them all, then total payments would be equal to the grey shaded area. Only the dark grey shaded area would actually result in a change in forest cover, however, while the entire amount of the light grey area would provide no additional forest conservation. It is important to note that this inefficiency is in terms of budgetary expenditures, and not in terms of economic costs. Payments to landholders who would not have deforested do not impose economic costs on the country, except for the transaction costs of making the payments, because there would be no opportunity costs (Pagiola, 2005; Pagiola and Bosquet, 2009).[20] We return to this issue in the next section.

An obvious solution to this problem of inefficiency is to target the PES program so that it only offers payments to landholders who would have deforested. This is not easy, however. All landholders have an incentive to claim they intend to clear their land, so as to be eligible for payments. Indeed, this incentive is particularly strong for landholders who would not have deforested.[21] Efforts to require additionality can easily create perverse incentives: inducing landholders to deforest land they might not otherwise have had any incentive to clear, so as to demonstrate their eligibility

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[19] Pagiola (2007) proposed a randomized controlled experiment to assess the impact of the PSAB program. Members of the first cohort of participants, whose contracts were to expire in 2008, would have been randomly selected to have their contracts renewed. As all members of this cohort had already elected to participate (and all were expected to wish to renew their contracts), there would have been no selection bias, leaving only the treatment effect. The proposal proved politically unpalatable to the Mexican authorities, however, and was not implemented.

[20] The budgetary implications for the government are important, however, as any national PES payments that do not reduce deforestation would not result in REDD payments to the country. Only the payments that do reduce deforestation would generate REDD funding.

[21] This problem mirrors that of setting national reference levels against which to measure reductions in deforestation—one of the most difficult challenges faced in designing a REDD mechanism (Angelsen, 2008).

for payments.[22] Such efforts would also tend to increase the transaction costs of the PES program, and so reduce its efficiency from that perspective. Finally, insisting on additionality may well run into resistance as it can easily be characterized as rewarding poor land stewards and penalizing good stewards. The desirability of requiring additionality in a PES program is, thus, less self-evident than many analysts make it out to be.

As participation in PES is voluntary for landholders, PES will also fail to change behavior whenever the offered payment is less than the opportunity cost of conservation (that is, when PES<RA-RF). This in itself is a desirable characteristic of PES: it is one of the reasons that PES is expected to be efficient (Pagiola and Platais, 2007). If the payment offered is lower than the value of the service, however, a different form of inefficiency is introduced: failing to enroll forest areas that it would be socially optimal to conserve (Pagiola, 2005). This is illustrated in Figure 2: PES1 is less than the value of the carbon sequestered in forests, and so the equilibrium level of forest, F_{PES1}, is less than the socially optimal level, F_C.[23]

5. Welfare considerations

The PES approach was conceptualized and undertaken as a mechanism to improve the efficiency of natural resource management, and not as a mechanism for poverty reduction. Nevertheless, many have assumed that PES will contribute to poverty reduction by making payments to poor land users, while others have warned of potential dangers (Landell-Mills and Porras, 2002; Kerr, 2002; Grieg-Gran and others, 2005; Pagiola and others, 2005; Ravnborg and others, 2007; Wunder, 2008).

Reducing deforestation involves opportunity costs: the difference in net benefits between forests and the best alternative land use.[24] Reducing deforestation also generates benefits. Approaches to reducing deforestation differ in who bears these costs and who receives the benefits.

Consider a regulatory approach, which bans any deforestation that would reduce forest cover below F_C. If this policy could be enforced, the opportunity costs would be borne entirely by landholders. They would be worse off by the dark grey shaded area in Panel A of Figure 3, as they would be unable to take advantage of the higher returns to agriculture and would have to accept the lower returns to forest. For the government, the budgetary cost would be limited to the cost of enforcing the

[22] As one example, when landholders in Matiguás-Río Blanco, Nicaragua, were told that a pilot PES program would only pay them for new trees that they planted and not for pre-existing trees, the common reaction was: "bueno, corto todo"—"fine, I'll cut them all" (Pagiola and others, 2007a). The program ultimately decided to make a one-time payment for pre-existing trees.

[23] Conversely, if the payment is higher than the value of carbon sequestration—for example, PES2 in Figure 2—then an excessive amount of forest would be conserved.

[24] As pointed out above, in cases where tenure is insecure, the opportunity costs of avoided deforestation may be negative. As PES cannot generally be implemented in these areas, however, the discussion that follows focuses on areas in which the opportunity costs of avoided deforestation are positive.

ban on deforestation. The benefits of reduced deforestation would be received by society as a whole—by the global community, in the case of the climate change mitigation effects resulting from reduced emissions. If the country received international compensation for avoided deforestation through a REDD program, these benefits would be transferred to the government. The government would then be better off by the entire amount of the two shaded grey areas, minus the costs of enforcing the ban on deforestation. The distributive effects of such a policy are an important reason that so much debate has arisen over the fairness of distribution of REDD.

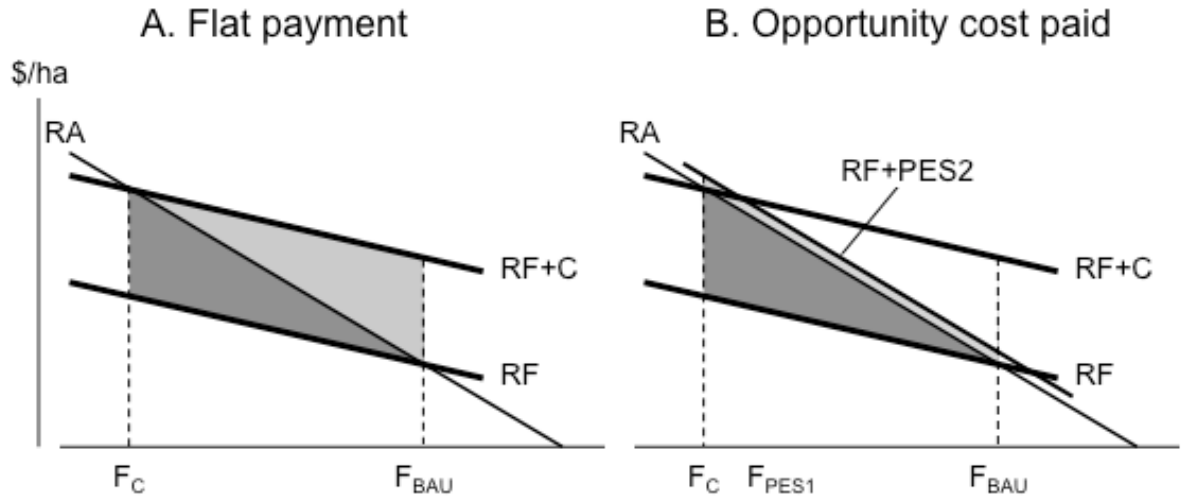

Figure 3: Welfare effects of different PES approaches

A PES policy that would have the identical effect on deforestation, on the other hand, would shift the burden of opportunity costs from landholders to the government, and make most landholders better off. This is shown in Panel A of Figure 3. A PES program in which landholders are paid the full value of avoiding the emissions of the carbon stored in their forest would receive a payment equal to the sum of the two shaded areas. The dark grey shaded area would offset their opportunity costs, and the light grey shaded area would be a net benefit; they would thus be better off by the light grey shaded area. The budgetary cost to the government of this program would equal the sum of the two grey areas (that is, the amount of payments made), plus the transaction costs of operating the program; these costs would be financed from REDD payments. The economic costs to the country would equal the sum of the dark grey shaded areas and the transaction costs; the rest of the payments are transfers and so are not an economic cost (Pagiola, 2005; Pagiola and Bosquet, 2009).

Figure 3 also illustrates the tension that exists between the goal of minimizing budgetary expenditures and that of having a positive welfare impact. In Panel B, an alternative PES payment policy is examined. Here, the payment offered to each landholder is a small amount above their individual opportunity cost. Clearly, such a policy would require some means to determine what each landholder's opportunity

cost is.[25] A substantial literature has developed that seeks to develop mechanisms by which landholders would reveal this information (Ferraro, 2008). Börner and Wunder (2008) estimate that a PES program in the Brazilian Amazon that was able to capture the entire rent would reduce transfers to land users by 35 percent to as much as 75 percent, compared to a program that paid a fixed price.

How the benefits of REDD would be shared has been the subject of intense debate. It is important to distinguish between (i) distribution of REDD revenues that is required in order to actually achieve a reduction in deforestation, and (ii) distribution motivated by ethical or development considerations. Without (i), there may be no avoided deforestation, and so no REDD revenues to distribute at all. This is not true of (ii). As long as participation in PES is voluntary, a PES program would be an effective way to ensure that no land user is made worse off by REDD. Any landholders who would be worse off could simply decline to participate. In addition, if PES payments are not perfectly set at the level of opportunity costs, a PES program would also provide an automatic distribution mechanism for at least some of the national benefits of REDD.

That a PES program could, if suitably designed, result in substantial gains to landholders does not automatically mean that it would reduce poverty. Much would depend on who would receive the payments. It has often been assumed that payments under a PES programs would go mainly to poor landholders. This hypothesized impact depends on the presumption that the landholders in marginal areas are poor (CGIAR, 1997; Heath and Binswanger, 1996). In practice, the answer in most countries is likely to be that both rich and poor landholders may receive PES (Chomitz and others, 2007). Pagiola and others (2007b), for example, find that poverty levels in the areas of highland Guatemala with potential for watershed PES vary substantially. Much will depend on who is actually cutting down forests—in areas with sufficiently secure tenure that PES can be implemented.

A related issue concerns the ability of landholder households to participate in a PES program. Worries that poorer households may not be able to participate in PES programs have been heightened by recent case studies in Costa Rica indicating that many participants in that country's PES program are relatively well-off (Ortiz Malavasi and others, 2002; Miranda and others, 2003; Zbinden and Lee, 2005). In Mexico, better-off ejidos were over-represented in terms of their participation in that country's PES program, while very highly marginalized ejidos were substantially under-represented (Muñoz and others, 2006).

[25] Note that although most current PES programs tend to base their payments on estimated opportunity costs, they are in fact similar to the policy shown in panel A, as they pay all participants the same amount, based on estimates of *average* opportunity cost, rather than attempting to pay each landholder their individual opportunity cost.

6. Conclusion

PES is only one of many tools that countries might implement as part of their strategies to reduce deforestation. It has many desirable characteristics, including the ability to focus conservation to areas with relatively low opportunity costs and ensuring that no participant is worse off as a result of participation. However, it is not a panacea. It is not applicable in many cases—including many areas with significant deforestation problems. Even when it is applicable, other measures may be preferable. In many cases, it needs to be used in combination with other tools. Designed appropriately, however, PES can make an important contribution to reducing deforestation. It is likely that many countries will find it a useful part of their strategy.

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