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INCREASING THE EFFICIENCY OF FOREST CONSERVATION: THE CASE OF PAYMENTS FOR ENVIRONMENTAL SERVICES IN COSTA RICA

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INTRODUCTION

Payments for avoided deforestation, whether made to nation states, regions, or local land users, can be seen as an international type of payment for environmental services (PES). Wunder (2005) defines PES as a voluntary transaction, where a well-defined environmental service (ES) (or a land use likely to secure that service) is being 'bought' by a (minimum one) ES buyer from a (minimum one) ES provider, if and only if the ES provider secures ES provision (conditionality).

This chapter links PES to reducing CO_2 emissions from deforestation and degradation (REDD), and discusses on the basis of a specific empirical example how the efficiency of PES can be increased through improved targeting. In terms of REDD policy, relevant efficiency questions include how to select the areas with the highest carbon content, the lowest conservation cost, the highest threat of clearing, and possibly the greatest synergies with other environmental services provided by the same landscape (side objectives). These questions are relevant at various levels of REDD policy design.

First, if REDD is to be achieved through the establishment of an international fund, like the Forest Carbon Partnership Facility (FCPF), limited funds require a procedure for deciding which countries, regions or projects are selected for REDD funding. Second, arguably any country or region participating successfully in REDD will also need to provide some local-level incentives for avoiding deforestation. PES is a highly relevant approach in this context. Yet, in establishing a national or regional PES scheme, similar questions arise on how land parcels are selected for programme inclusion, and about the size and allocation of conservation payments. Finally, increasing the efficiency of current forest conservation spending (whether in the form of PES or other approaches[1]) can be seen as an important complement to a strategy of raising additional funds for reducing CO_2 emissions through avoided deforestation. 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'). Moreover, demonstrating efficiency can be important in attracting new funding sources, particularly from the private sector.

Below we discuss the issues, potentials and challenges of improved PES targeting, focusing on three targeting criteria: environmental services (ES) provided, threat of ES loss in the absence of PES ('additionality'), and costs of ES provision. In addition to drawing on previous approaches from the literature, we adapt results from Wünscher et al (2006; 2008), where a spatial targeting tool was developed for the Nicoya Peninsula in Costa Rica. Other issues in PES design not considered here include poverty impacts (e.g., Pagiola et al, 2005; Zbinden and Lee, 2005; Engel and Palmer, 2008), leakage (e.g., Murray et al, 2002; Shongen and Brown, 2004), dealing with weak property rights (Engel and Palmer, 2008), and whether to pay local communities or individuals (Rojahn and Engel, 2007).

The remainder of this chapter first highlights the basic idea of PES. It then continues to emphasize the importance of PES targeting and identifies the major challenges involved.

Using examples from the literature, we then illustrate to what extent improved targeting can increase the efficiency of forest conservation spending. The challenges with regard to the implementation of improved targeting are discussed in the subsequent section. The chapter closes with our conclusions.[2]

BASIC IDEA OF PES AND THE EXAMPLE OF COSTA RICA

PES is increasingly used as a direct instrument in conservation. Wunder et al (2008) provide an overview of a number of government- and private-sector-financed PES schemes functioning across the world. National programmes exist, for instance, in Mexico (see Alix-Garcia et al, chapter 13, this volume) and the United States (e.g. Claassen et al, 2008). The idea lies in translating external values of the environment into real financial incentives at the local level. PES is based on the 'beneficiary-pays' rather than the 'polluter-pays' principle, thus providing an alternative income source to local (often poor) land owners. Moreover, as various services may be provided jointly with the adoption of a single specific land use (e.g. forest conservation), payments for one specific 'umbrella' service (e.g., carbon-stock conservation) can sometimes enhance the provision of other services (e.g. biodiversity conservation and hydrological services) as 'by-products'. With a growing demand for carbon mitigation and the chance to be integrated into a post 2012 carbon market, REDD has particular potential to act as an umbrella service.

One of the most well-known schemes, the Costa Rican national PES scheme (*Pagos por Servicios Ambientales* or PSA), is illustrative (Figure 12.1). In this scheme, the implementing agency, FONAFIFO[3], bundles funding from various sources. While most funds are drawn primarily from the Costa Rican public through a national fuel tax, other sources include international donors and some private firms, e.g. ones interested in improving or maintaining high water quality as an input to production. Payments are made by FONAFIFO to land owners in return for the latter adopting specific land-use practices. Forest conservation accounts for more than 90 per cent of current payments, i.e., the Costa Rican scheme is essentially a PES scheme for avoided deforestation and forest degradation. The remaining 10 per cent of current payments are made for the establishment of timber plantations, renovation of natural forests through land retirement and agroforestry. The programme explicitly recognizes four categories of environmental services: carbon mitigation, biodiversity conservation, hydrological services, and scenic beauty. Poverty alleviation is a further side objective of the programme (see Pagiola, 2008, for further details on the Costa Rican PSA programme).

Figure 12.1 here

TARGETING – RELEVANCE AND CHALLENGES

The Costa Rican example also highlights the relevance of PES targeting. By end-2004, 230,000 ha were under contract in the Costa Rican PSA programme. The number of applications far exceeded the available budget, with more than 800,000 ha of applications pending at the same time. Only sites from defined priority areas are eligible for programme entry, although exceptions are made. No differentiation of applicant sites is made within priority areas according to expected benefit delivery, and priority areas are coarsely defined: they cover nearly three fifth (29,872 km^2) of the national territory (51,101 km^2) (own calculation based on data from ITCR, 2004).

Site enrolment into the programme is made on a continuous first-come-first-serve basis. Payments are fixed as a flat rate for each land use (for example, 64 US$/ha/year since 2006 for forest conservation). Wünscher et al (2008) developed a spatial targeting tool to demonstrate that the amount of environmental services achieved with a given conservation budget could be substantially enhanced through improved targeting. We considered three specific targeting criteria: benefits, threat levels, and participation costs.

First, targeting could be based on the level of actual ES delivered from any given site. In the case of REDD policy, the main ES to consider would be carbon storage. Countries establishing a PES scheme to achieve REDD commitments may consider bundling REDD funding with other sources of funding aimed at different ES, as in the Costa Rican case. Biodiversity considerations are also often voiced in discussions on the setup of an international fund for REDD, such as the FCPF.

In practice, this poses the challenge of dealing with potential trade-offs between multiple service-provision objectives, choosing among or combining multiple indicators available even for single objectives, and considering spatial interactions. For example, there may be significant synergies between the goals of achieving biodiversity protection and of preserving carbon stocks in standing forests, as both depend crucially on the preservation of existing habitat, avoiding its conversion or degradation; yet areas providing the highest carbon benefits are not necessarily also the most biodiversity-rich areas. Approaches that have been used in the literature to deal with multiple objectives and/or indicators include using a weighted sum of standardized indices (Pagiola et al, 2004), or applying a distance function (Ferraro, 2004). In Wünscher et al, 2008 we use the former approach, applying a *z*-value normalization[4] and equal weights both within and across objectives to compute a total ES score. In the case of REDD, we would include the carbon content of different vegetation types in the ES score vector (see Wünscher et al, 2008 for further details on data and indicators used).

A second targeting criterion to be considered is the spatially variable level of threat. Sites may have high ES scores, but may be at low or no threat to be deforested. This refers to the issue of additionality, discussed particularly in chapters 10 (Harris et al) and 11 (Pfaff and Robalino) in this volume. The additionality of Costa Rica's PSA programme has been highly debated (e.g., Pfaff et al, 2007; Sills et al, 2006). For example, Pfaff et al (2007) find very low impact of the PSA scheme on deforestation. Considering threat in targeting poses the challenge of estimating spatially explicit baseline scenarios of deforestation. We know that spatial factors such as road building or other infrastructural investments have a powerful impact on deforestation, while remote areas due to the excessive transport costs remain under passive protection. Paying for the latter type of areas provides no additionality of service provision. Brown et al (undated) lists three conceptual approaches to address this: analytical models (e.g., simple logistic curve based on population density), simulation (programming) models, and regression models (see Harris et al, chapter 10, in this volume, for a detailed discussion of baseline modelling). In Wünscher et al, 2008, we used the results and data from a spatially explicit regression model of Pfaff and Sanchez-Azofeifa (2004) in order to compute site-specific rates of expected deforestation in the absence of PES.

Finally, countries, regions and land users differ in their costs of ES provision. ES provision costs include opportunity costs (the difference in income between the most profitable land use and the one contracted under the PES scheme), direct conservation cost (e.g., firebreaks, fencing), and transaction costs (e.g., obtaining legal title, information gathering). Flat and fairly low per-hectare payments, as in the Costa Rican PSA scheme, give high production rents to landowners with low-to-zero ES provision costs, while those with high provision costs are unlikely to participate in the scheme. When the opportunity costs of conservation within a target area are highly disparate, large cost inefficiencies can arise from a flat-rate payment approach. If a site has a high ES score and threat of deforestation, it may be worth paying more for its inclusion in the programme, while sites with low participation costs would likely still participate at lower payment levels. This implies that the amount of total ES achieved with a given budget could be increased by differentiating payments on the basis of participation costs, considering these costs as a third targeting criterion. However, estimating site-specific costs, particularly opportunity costs, can be challenging. Landowners may act strategically in reporting costs, and a number of difficult-to-measure factors may influence individual opportunity costs or the minimum payment required to compensate for given costs (e.g., risk considerations, cultural preferences, or distrust towards the service buyers).

The main approaches for estimating opportunity costs have included using land values, computing farm budgets, or inferring values on the basis of farm and household data. Moreover, inverse auctions could be applied to elicit landowners' minimum willingness to accept for including a site in the programme, as for example in the U.S. Conservation Reserve Programme and the Australian Bush Tender scheme (see Ferraro, 2008, for a discussion of auction design). In Wünscher et al, 2008, we used survey data to estimate ES provision costs, as will be described in the following section.

IMPROVING THE EFFICIENCY OF PES THROUGH IMPROVED TARGETING

Wünscher et al (2008) conducted a random sample of 107 forest owners in Nicoya Peninsula to compute site-specific per-hectare estimates of returns from pasture, and used the spatially explicit data to compute the potential efficiency gains from improved targeting. Specifically, we developed a targeting tool that combines all three of the above listed targeting criteria to maximize ES additionality (defined as the total ES score multiplied by the expected probability of deforestation) with a given budget, while allowing for flexible payments equalling site-specific participation costs. The results were compared to a baseline scenario, in which sites are selected purely on the basis of whether they lie within the pre-defined priority areas and where payments are held fixed at a level of 40 US$/ha[5] (this baseline also sets the budget limit for the improved targeting scenario).

Given a fixed budget of 30,028 US$, we find that the total ES score and ES additionality both nearly doubled through improved targeting (from 52,148 to 98,259, and from 1,969 to 4,033, respectively). Similar results were found by Alix-Garcia et al (2005; chapter 13, this volume) for the Mexican PES scheme and by Ferraro (2003) for an easement programme for Lake Skaneateles in the US. The former found a four-fold increase in efficiency through improved targeting while the latter shows that the non-consideration of benefit/cost information reduced environmental benefits obtained by more than 50 per cent. We also ran additional scenarios allowing for the consideration of only some of the targeting criteria. We found that most of the potential for efficiency gain in the Costa Rican context comes from flexible payments being customized to highly variable participation costs. However, in other countries with either higher average deforestation risks than in Costa Rica or marked spatial differences in site-specific service provision, these other factors could come to dominate the overall efficiency outcomes and boost the efficiency gains from targeting to levels that are much higher than in the Costa Rican case.

CHALLENGES IN IMPLEMENTING IMPROVED TARGETING

Implementing improved targeting is not without challenges. In addition to the aforementioned scientific challenges, administrative challenges include the fact that an application of our improved targeting tool would require simultaneous decisions on all applications after a deadline, rather than as now, continuously as applications are filed. Perhaps most importantly, targeting is likely to face political challenges, especially as it may be perceived as inequitable, thus diminishing popular (and voters') support, while channelling public scheme payments to selected recipients only. In particular, landowners may resist differential payments once homogenous payments have already been introduced, as these may be seen as arbitrary discrimination. Thus, transparency of the selection process is key. Inverse auctions where landowners pose bids of their minimum willingness-to-accept for being included in the scheme may be able to overcome this problem. However, if landowners are poor, and buyers are much better off, as is arguably the case in many REDD scenarios, it may be seen as unethical to squeeze service providers for the last cent of rent, in favour of maximizing returns to the service buyers. On the other hand, implementing bodies may have latent side objectives of their own (e.g., PSA may be seen as compensation for strict environmental legislation rather than for achieving additional environmental benefits). Finally, gross environmental efficiency gains need to be compared to the incremental transaction costs of targeting. In our study, we estimated these costs for Costa Rica to amount to approximately 0.27 per cent of the total PSA budget, thus being negligible with respect to the potential efficiency gains.

CONCLUSIONS

PES is an increasingly widespread instrument both for financing and implementing conservation. It is also a very relevant instrument in the context of REDD. The Costa Rican PSA scheme is often considered a leading model in this regard, but is currently being criticized for not being sufficiently efficient in achieving additional environmental benefits. With 90 per cent of the scheme's payments allocated to forest conservation, it is also a highly relevant example for the discussion of REDD. We find that improved targeting could substantially increase the efficiency of the programme, in the sense that total environmental services achieved with a given budget were found to nearly double when environmental benefits, threat, and participation costs are jointly considered in site selection. This finding confirms similar results of studies conducted on PES in Mexico and the US.

Moreover, efficiency should be considered more generally when upscaling PES (e.g., in form of a global fund of the FCPF-type), or the selection among potential conservation projects. Nevertheless, targeting involves incremental implementation costs and may face scientific, administrative and in particular political challenges. Approaches for overcoming these challenges include: (i) development of simple targeting tools, (ii) improving data availability, (iii) implementing targeting from the very start of a programme, and (iv) using inverse auctions to elicit individual participation costs.

There are thus several lessons to be learnt also for the design of nascent REDD mechanisms. Spatial variation in the service provided (carbon content) typically occurs across areas with respect to biophysical factors (regional differences in tree height and growth density),and the history of anthropogenic interventions (logging, burning, clearing, or secondary regrowth), which in large forested regions such as the Amazon can lead to significant differences (Saatchi et al, 2007). Threat levels and opportunity costs may vary even more in space, thus introducing real dangers of paying for ‘hot air’ (protection of *de facto* unthreatened forest), and conversely offering insufficient payments to those with real intentions and motivation for forest clearing. REDD mechanisms should thus use local payments that are flexible in space, based on spatially-explicit threat baselines and opportunity-cost calculations.

REFERENCES

Alix-Garcia, J., de Janvry, A. and Sadoulet, E. (2005) *The Role of Risk in Targeting Payments for Environmental Services*, [Online] Available at: http://ssrn.com/abstract=836144 [accessed 12 August 2007].

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.

Brown, S., Hall, M., Andrasko, K., Ruiz, F., Marzoli, W., Guerrero, G. Masera, O., Dushku, A., Dejong, B. and Cornell J. (undated) *Baselines for Land-use Change in the Tropics: Application to Avoided Deforestation Projects,* [Online] Available at: http://ies.lbl.gov/iespubs/61456.pdf [accessed 10 April 2008].

Claassen, R., Cattaneo, A. and Johansson, R. (2008) 'Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice', *Ecological Economics,* 65 (4): 737-52.

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., Wünscher, T. and Wunder, S. (2007) 'Increasing the efficiency of conservation spending', in C.B. Schmitt, T. Pistorius and G. Winkel (eds) *A Global Network of Forest*

Protected Areas under the CBD: Opportunities and Challenges. Proceedings of an international expert workshop held in Freiburg, Germany, May 9-11, 2007. Freiburg Schriften zur Forst- und Umweltpolitk, 16. Remagen: Kessel.

Engel, S., Pagiola, S. and Wunder, S. (2008) 'Designing payments for environmental services in theory and practice – an overview of the issues', *Ecological Economics*, 65 (4): 663-674.

Ferraro, P. (2001) 'Global habitat protection: limitations of development interventions and a role for conservation performance payments', *Conservation Biology*, 15 (4): 990-1000.

Ferraro, P. (2003) 'Conservation contracting in heterogenous landscapes: an application to watershed protection with threshold constraints', *Agricultural and Resource Economics Review*, 32 (1): 53-64.

Ferraro, P. (2004) 'Targeting conservation investments in heterogenous landscapes: a distance function approach and application to watershed management', *American Journal of Agricultural Economics*, 86 (4): 905-18.

Ferraro, P. (2008) 'Asymmetric information and contract design for payments for environmental services', *Ecological Economics*, 65 (4): 810-21.

Ferraro, P. and Kiss, A. (2002) 'Direct payments to conserve biodiversity', *Science*, 298 (5599): 1718-9.

Ferraro, P. and Simpson, D. (2002) ‘The cost-effectiveness of conservation payments’, *Land Economics*, 78 (3): 339–53.

ITCR (Instituto Tecnológico de Costa Rica) (2004) *Atlas Digital de Costa Rica*, Cartago: Escuela de Ingeniería Forestal.

Murray, B.C., McCarl, B.A. and Lee H. (2002) *Estimating Leakage from Forest Carbon Sequestration Programs*, Working Paper 02_06, North Carolina: RTI (Research Triangle Institute) International.

Pagiola, S. (2008) ‘Payments for environmental services in Costa Rica’, *Ecological Economics*, 65 (4): 712-24.

Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murqueitio, E., Ramirez, E., Rosales, M. and Ruiz, J.P. (2004) *Paying for Biodiversity Conservation Services in Agricultural Landscapes*, Environment Department Paper 96, Environmental Economics Series, The World Bank Environment Department, Washington D.C.: World Bank.

Pagiola, S., Arcenas, A. and Platais, G. (2005) ‘Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America’, *World Development*, 33 (2): 237-53.

Pfaff, A. and Sanchez-Azofeifa, G.A. (2004) ‘Deforestation pressure and biological reserve planning: a conceptual approach and an illustrative application for Costa Rica’, *Resource and Energy Economics*, 26: 237-54.

Pfaff, A., Robalino, J.A. and Sanchez-Azofeifa, G.A. (2007) *Payments for Environmental Services: Empirical Analysis for Costa Rica*, [Online] Available at: http://www.apec.umn.edu/documents/AlexPfaffEnvirSem07.pdf [accessed 12 August 2008].

Rojahn, A. and Engel, S. (2007) *Direct Payments for Biodiversity Conservation, Watershed Protection and Carbon Sequestration: Contract Theory and Empirical Evidence*, mimeo, Chair of Environmental Policy and Economics, ETH Zurich.

Saatchi, S.S., Houghton, R.A., dos Santos Alvala, R.C., Soares, J.V. and Yu, Y. (2007) 'Distribution of aboveground live biomass in the Amazon basin', *Global Change Biology*, 13 (4): 816-37.

Sills, E., Arriagada, R., Pattanayak, S., Ferraro, F., Carrasco, L., Ortiz, E. and Cordero, S. (2006) *Impact of the PSA Program on Land Use*, paper presented at the Workshop on Costa Rica's Experience with Payments for Environmental Services, San José, 25-26 September 2006.

Sohngen, B. and Brown, S. (2004) 'Measuring leakage from carbon projects in open economies: a stop timber harvesting project in Bolivia as a case study', *Canadian Journal of Forest Research*, 34: 829-39.

Swart, J.A.A., Ferraro, P.J. and Kiss, A. (2003) 'Will direct payments help biodiversity?', *Science*, 299 (5615): 1981-2.

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: lessons learnt for the design of payments for environmental services programs', *Ecological Economics*, 65 (4): 834-52.

Wünscher, T., Engel, S. and Wunder, S. (2006) 'Payments for environmental services in Costa Rica: increasing efficiency through spatial differentiation', *Quarterly Journal of International Agriculture*, 45 (4): 319-37.

Wünscher, T., Engel, S. and Wunder, S. (2008) 'Spatial targeting of payments for environmental services: a tool for boosting conservation benefits', *Ecological Economics*, 65 (4): 822-33.

Zbinden, S. and Lee, D.R. (2005) ‚Paying for environmental services: an analysis of participation in Costa Rica's PSA program', *World Development*, 33 (2): 255-72.

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[1] The choice between direct policy instruments like PES and more indirect instruments (e.g., integrated conservation and development projects) is an efficiency issue in itself (see, for example, Ferraro and Simpson, 2002; Ferraro and Kiss, 2002; Ferraro, 2001; Swart et al, 2003). In general, this choice should be based on a careful analysis of the sources of market failure for a specific situation (Engel et al, 2008). In this chapter we focus on the particular instrument of PES and on the issue of efficient instrument design. Nevertheless, similar considerations apply to conservation spending more generally.

[2] This chapter is based on Engel et al (2007).

[3] *Fondo Nacional de Financiamiento Forestal*.

[4] The z-normalization yields comparable scores with a mean equal to zero and standard deviation and variance equal to one.

[5] The Costa Rican PSA programme used to pay US$40/ha/year before it was raised to US$64/ha/year in 2006.