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Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries

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ABSTRACT

Payments for environmental services (PES) are an innovative approach to conservation that has been applied increasingly often in both developed and developing countries. To date, however, few efforts have been made to systematically compare PES experiences. Drawing on the wealth of case studies in this Special Issue, we synthesize the information presented, according to case characteristics with respect to design, costs, environmental effectiveness, and other outcomes. PES programs often differ substantially one from the other. Some of the differences reflect adaptation of the basic concept to very different ecological, socioeconomic, or institutional conditions; others reflect poor design, due either to mistakes or to the need to accommodate political pressures. We find significant differences between user-financed PES programs, in which funding comes from the users of the ES being provided, and government-financed programs, in which funding comes from a third party. The user-financed programs in our sample were better targeted, more closely tailored to local conditions and needs, had better monitoring and a greater willingness to enforce conditionality, and had far fewer confounding side objectives than government-financed programs. We finish by outlining some perspectives on how both user- and government-financed PES programs could be made more effective and cost-efficient.

1. Introduction

As ecosystems have become increasingly degraded worldwide, and the valuable environmental services (ES) that they provide lost or reduced, there has been a growing search for solutions. Among these, the payments for environmental services (PES) approach has been applied increasingly often in both developed and developing countries. Numerous PES and PES-like initiatives are being implemented, at a wide variety of scales ranging from small watersheds to entire nations. Despite this growing interest, there have been few efforts to systematically document the characteristics and effectiveness of different PES programs, and even fewer efforts to compare them. This Special Issue of *Ecological Economics* has attempted to fill this gap by providing detailed case studies of some of the most important PES programs.

In this concluding article, we synthesize the information presented in the case studies included in this Special Issue, and make a structural comparison of their characteristics with respect to design, costs, environmental effectiveness, and

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livelihood outcomes. Finally, we draw lessons from the analysis of these cases for improved PES design.

We begin by briefly reviewing our sample cases of PES programs, highlighting important design characteristics (Section 2). We then examine the available evidence on the effectiveness of PES programs in achieving environmental objectives (Section 3) and in helping reduce poverty (Section 4). We close with some conclusions and policy perspectives (Section 5).

2. PES case studies

In this Special Issue we follow Wunder (2005) in defining PES as (a) a *voluntary* transaction where (b) a *well-defined* environmental service (ES) or a land use likely to secure that service (c) is being 'bought' by a (minimum one) service *buyer* (d) from a (minimum one) service *provider* (e) if and only if the service provider secures service provision (*conditionality*).

The sample of PES case studies presented in this Special Issue is built around those presented at the workshop on PES Methods and Design in Developing and Developed Countries, held in Titisee, Germany, in 2005, with some additions. The main criteria for selecting cases were closeness to the PES concept (as defined above), broad geographical coverage, significance (in terms of area and number of people covered), years in operation, and information availability. The cases and their main characteristics are listed in Table 1.[1] To help improve our basis for comparison, we include in our discussion here three PES programs that were presented and documented at the Titisee workshop: the Vittel watershed protection program in France, the Wimmera groundwater salinity control pilot program in Australia, and the Northeim agri-environmental pilot program in Lower Saxony, Germany. Box 1 provides capsule descriptions of these cases. We also bring in other cases from the literature when applicable. Although we aimed to capture the major types of PES programs and cover a range of cases (developed and developing countries, different continents, small and large-scale programs), it should be noted that our sample cases are not necessarily representative of all PES and PES-like programs in existence. In particular, the relative share of different kinds of programs in our sample does not reflect their relative prevalence on the ground. For example, all four current cases of government-funded PES programs in developing countries are included in our sample, whereas only a small fraction of known user-financed programs are included.

Table 1 summarizes the main characteristics of the PES programs in our sample, grouped according to financing source. As discussed in the Introduction to this Special Issue, there is an important distinction between user-financed PES programs, in which the service buyers are the actual service users, and government-financed PES programs, in which the service buyers are a third party (typically the government). User-financed programs are fully voluntary for both ES providers and users, who can enter (and exit) contracts voluntarily.[2] In contrast, government-financed programs are typically only voluntary on the provider side. To the extent that these programs are financed through user fees, the fees are mandatory. Providers, on the other hand, are not forced into PES programs, with the exception of China's SLCP, where some involuntary participation has been observed.

Among user-financed programs, the classic program in both developing and developed countries involves a single buyer and a single-service. However, several programs within this group, such as Pimampiro and Los Negros, used external funds to co-finance start-up costs, and are thus not purely user-financed. Non-governmental organizations (NGOs) frequently function as intermediaries between buyers and sellers in programs at smaller spatial scales, although examples of this type can also be found at larger scales.[3] Among government-financed programs, most rely on annual allocations through the normal budgetary process, but some have dedicated funding sources through earmarked user fees. Developed-country programs sometimes receive funding from several levels of government, while developing country programs can receive donor funding. The borders between user- and government-financed PES programs can be blurred, however. Many programs are in fact hybrids, mixing government and user financing. Costa Rica's PSA program, for example, is financed primarily from government funds, but also includes payments from service users and international agencies and NGOs.

In considering the wide array of programs that are sometimes labeled PES, one often comes across programs that are hard to categorize. Zimbabwe's CAMPFIRE program is one of these. At one level, it seems to meet many of the criteria for a PES program, as given in our definition. To the extent that it does not (for example, conditionality is weak), it is hardly the only program to fail to fully satisfy all criteria. Yet, one of the two services provided by CAMPFIRE – landscape values, access to which is sold to safari operators – is not an externality, since non-consumptive use of wildlife areas occurs on-site.[4] This is fundamentally different from other services in our sample. For instance, farmers who through their land-use decisions affect water flows have no way to prevent downstream water users from enjoying the benefits of their actions. CAMPFIRE's problem is qualitatively different, because there is no 'market failure' at hand: the Rural District Councils can directly apply user fees in return for access to the

[1] The table also shows the sources for each case, which are all in this Special Issue with the exception of the three described in Box 1. To ease readability, we do not repeat the references when discussing case studies in this issue or Box 1. Supplementary inputs for the table were also requested from the authors where the corresponding information was not available in the text source. The final responsibility for the information in the table remains with us, rather than the case-study authors.

[2] For hydrological services, this assumes that the service user is the water use enterprise rather than the water end-user. In some cases (such as Pimampiro), these enterprises finance their payments with additional fees levied on their end-users. These cases are a minority, however: in most cases, water use enterprises use their existing operating budgets to make payments (Pagiola and Platais, 2007).

[3] For example, the Water Fund (FONAG), an innovative watershed financing initiative in the city of Quito, was established with the assistance of The Nature Conservancy (TNC) (Echavarría, 2002).

[4] Thus CAMPFIRE deals with services that generate *direct use* value, in the terminology of the Total Economic Value (TEV) framework (Pearce and Warford, 1993). In contrast, the other programs deal with services that generate *indirect use, option, or existence values*.

Table 1 – Summary characteristics of PES case-study programs

Case, country (source)	Environmental services		Who buys?	Who else benefits?[a]	Who sells?	Who initiated?	Start year	Spatial scale and current size	Obstacles to implementation
	Targeted	Paid for							
User-financed programs									
Los Negros, Bolivia (Asquith et al., 2008-this issue)	Watershed and biodiversity protection	Forest and páramo conservation	Pampagrande Municipality, US Fish and Wildlife Service	Local water users, mostly irrigators	Santa Rosa farmers (46 landowners)	Fundación Natura (NGO)	2003	Upper Los Negros watershed (2774 ha)	Trust building slow, low water-user payments
Pimampiro, Ecuador (Wunder and Albán, 2008-this issue)	Watershed protection	Forest and páramo — conservation/ restoration	Metered urban water users (20% fee)	Unmetered water users, irrigators	N. América Coop. (81% of members)	CEDERENA (NGO)	2000	Palahurco watershed, left side (496 ha)	Monitoring costs, free riders, link land use–service
PROFAFOR, Ecuador (Wunder and Albán, 2008-this issue)	Carbon sequestration	Re- and afforestation	FACE (Electricity consortium)	Climate-change mitigation beneficiaries	Communal and individual landholders	PROFAFOR (company set-up by buyer)	1993	Highlands and coastal regions (22,300 ha)	Fires, grazing — constraints in communal capacity and incentives
Vittel (Nestlé Waters), France (Perrot-Maître, 2006)	Water quality	Best practices in dairy farming	Vittel	River basin agency	Dairy farmers — all 27 farms enrolled	Vittel	1993	Spring catchment (5100 ha)	Integrating non-agricultural sector (golf course, etc.)
Government-financed programs									
Sloping Land Conversion Program (SLCP), China (Bennett, 2008-this issue)	Watershed protection	Cropland retirement, conversion to grasslands, re- and afforestation	Central government	Downstream water users, timber consumers	Rural households	Central government	Pilot 1999–2001, full scale 2002–	7.2 million ha retired and 4.92 million ha reforested (2005)	Local government administration overburdened; local governments retain farmer payments
Payments for Environmental Services (PSA)[b], Costa Rica (Pagiola, 2008-this issue)	Water, biodiversity, carbon, scenic beauty	Forest conservation, timber plantations, agroforestry	FONAFIFO (autonomous state agency)	Tourism industry, water users	Private landholders, indigenous communities	Government, in Forest Law	1997	National, target areas, 270,000 ha (end 2005)	Funding availability, knowledge of land use–service links
Payments for Hydrological Environmental Services (PSAH), Mexico (Muñoz-Piña et al., 2008-this issue)	Watershed and aquifer protection	Conservation of pre-existing forest area	CONAFOR (state forest agency)	All water users in watershed and those using aquifers	Communal and individual landowners	Ministry of Environment, Forest & Water Commissions	2003	National, priority areas, 600,000 ha (2005)	Rent seeking by communities with timber firms

Conservation Reserve Program (CRP), USA (Claassen et al., 2008-this issue; Baylis et al., 2008-this issue)	Water, soil, wildlife protection (also air, carbon)	Benign agricultural practices and agricultural land retirement	US government	Natural resource users (*e.g.* water users, recreation)	Farmers	US government	1985	14.5 million ha (2005)	Links land use–service little researched; political factors reduce efficiency
Environmental Quality Incentives Program (EQIP), USA (Claassen et al., 2008-this issue; Baylis et al., 2008-this issue)	Water, soil, wildlife protection (also air, carbon)	Benign agricultural practices and ag. land retirement	US government	Natural resource users (*e.g.* water users, recreation)	Farmers	US government	1996	Not area-driven	High admin. costs and transactions cost of customized schemes
Environmentally Sensitive Area (ESA) and Countryside Stewardship Scheme (CSS), United Kingdom (Dobbs and Pretty, 2008-this issue)	Biodiversity, recreation, watershed protection	Benign agricultural practices and ag. land retirement	UK government + EU	Natural resource users (*e.g.* recreation, water users)	Farmers in targeted areas	UK government (first in England)	ESA: 1986–2003; CSS:1991–2003	England (2003): ESA: 640,000 ha CSS: 530,620 ha	Not available
Northeim model project, Germany (Bertke and Marggraf, 2004)	Agrobiodiversity	Agricultural practices that raise species richness	Private foundation (targeted at CAP)	Recreational beneficiaries of regional biodiversity	Farmers in model region	University of Göttingen, with district authorities	Pilot 2000–03; payments 2004–	288 ha grassland (28 farmers, 159 fields), Northeim District	Service property rights/metric; monitoring costs; risk of reducing other incentives
Wimmera, Australia (Shelton and Whitten, 2005)	Groundwater salinity control	Land-use changes reducing groundwater recharge	Australian government	Downstream water users	Landholders in Steep Hill Country	Wimmera Catchment Management Authority	2005	28,000 ha (10%) in steep hill country in Upper Wimmera	Not available
PES-like programs									
CAMPFIRE, Zimbabwe (Frost and Bond, 2008-this issue)	Hunting, landscape beauty, biodiversity conservation	Conservation of/access to natural landscapes	Private safari operators and international donors	Global conservation community	Communities through Rural District Councils (RDCs)	Zimbabwe Park authority, with various NGOs	1989	Communal lands 14.4 million ha (target blocks 4.3 million ha)	Power struggles, RDC non-devolution, recentralisation
Working for Water (WfW)[b], South Africa (Turpie et al., 2008-this issue)	Watershed protection, biodiversity	Clearing alien invasive plants	Central government (85%) and water users (15%)	Landowners whose land productivity increases	WfW, by employing workers	Government of South Africa	1995	National, not area-driven	High costs of clearing

[a] In the case of government-financed programs, the government as buyer usually derives no own benefit, so the "who else benefits?" column here expresses the prime beneficiaries from the respective government program. In almost all cases, the "global community" is a lateral beneficiary (carbon, biodiversity), which is thus not repeated.

[b] These programs include small user-financed components.

Box 1 Supplementary PES case studies from the Titisee workshop

The Vittel (Nestlé Waters) watershed protection program in Eastern France

Since 1993, mineral water bottler Vittel has conducted a PES program in its 5100 ha catchment at the foot of the Vosges Mountains, in order to maintain aquifer water quality to its highest standard. The program pays all 27 farmers in the watershed of the "Grande Source" to adopt best practices in dairy farming. The program is implemented through Agrivair, a buyer-created agricultural extension agency, which has a solid local base and is trusted by farmers. It has persuaded farmers to reconvert to extensive low-impact dairy farming, including abandoning agrochemicals, composting animal waste, and reducing animal stocks. The program is fairly complex in design, combining conditional cash payments with technical assistance, reimbursement of incremental agricultural labor costs, and even arrangements to take over lands and provide usufruct rights of the farmland to the farmers. Contracts are long-term (18–30 yr), payments are differentiated according to opportunity costs on a farm-by-farm basis, and both land use and water quality are closely monitored over time. Total costs (excluding the intermediary's transaction costs) have been almost US$25 million over 1993–2000. Through carefully researched baselines, an improvement of the service vis-à-vis the declining ES baseline is well-documented, and the high service value clearly makes the investments profitable.

The Wimmera Catchment pilot program for salinity control in Victoria, Australia

This program, initiated in 2005, aims to reduce recharge to saline aquifers. It focuses on land uses in the steep, hilly part of the watershed — a 28,000 ha area within the Upper Wimmera Catchment. The beneficiaries are various downstream water users. The Catchment Management Authority (CMA) is using taxpayer money to organize inverse auctions to obtain the most desired land-use changes from upstream landowners at the lowest possible cost. Landholders submit voluntary offers to provide the targeted services, and the CMA ranks these offers according to cost per unit of expected salt reduction. Then it approves applications for cash payments up to a budget limit or a preset reserve price. The program is designed as conditional, but this is *de facto* reduced by high upfront payments and low sanction risks. Nevertheless, compliance is still expected to be high, due to local mechanisms of social control. Start-up transaction costs have been relatively high, but this is seen by the CMA as an investment for future upscaling of the program.

The Northeim Model Project for agrobiodiversity in Lower Saxony, Germany

Like Wimmera, the Northeim project is a pilot program using tendering procedures to determine payments to farmers for changed land uses, with a view to a later upscaling of the experience by incorporating it into the EU's Common Agricultural Policy. A private foundation pays farmers to reduce agricultural intensification and to adopt practices that favor species richness, boosting both biodiversity (regionally endangered plant species) and recreational benefits from landscape beauty (enjoyed by visitors). Payments were carried out since 2004 to 28 farmers (out of 159 bids) on 288 ha. The University of Göttingen assists in this trial to scientifically document the outcomes.

Sources: Perrot-Maître (2006), Shelton and Whitten (2005), Bertke and Marggraf (2005), supplemented by personal communications from the authors during and after the Titisee workshop.

wildlife sites, and thus internalize the benefits. The second service provided by CAMPFIRE – biodiversity conservation being closely monitored and paid for by external donors over a couple of decades – clearly constitutes an externality. Payments were also made explicitly to compensate communities' direct and opportunity costs for more biodiversity-friendly land management. However, donor payments for these services occurred under the logic of integrated conservation and development programs (ICDPs) rather than as conditional PES transfers. Thus, in CAMPFIRE's notable achievements, we agree with the case-study authors that while CAMPFIRE "shares some features with PES" and can provide useful lessons for PES implementation, it is not a PES program *sensu strictu*.[5]

A second case that differs significantly in function from our PES definition is the government-financed Working for Water (WfW) program in South Africa. Here, unemployed workers are hired to clear exotic invasive species, especially of highly water-consuming trees — primarily on public lands, but also on some private lands. This improves water availability downstream and protects native biodiversity — two clear externalities. But while WfW usually undertakes periodic follow-up clearings, it seemingly does not exercise the same continuous control over land access and ES provision as in all our remaining cases where contracts are with land stewards. This may especially be a problem on privately own lands.[6] ES buyers will normally require that "the seller has legal or *de facto* control over the habitat's [or land area's] fate for the duration of the contract"(Ferraro, 2008). In this sense, the WfW case is atypical for PES, and resembles more the generic family of environmental food-for-work programs (Holden et al., 2006).

[5] This may also indicate that the Wunder (2005) definition, which we use in the above, does not adequately delimit externality ES from ES that can be internalized by land stewards.

[6] On public lands, WfW may have more continuous control over ES provision, but here the public sector comes to simultaneously act as both the buyer and the seller of ES — an unconventional set-up for a PES program.

Many of our other cases also have characteristics that fail to fully conform to our definition of PES in one or more respects, and it becomes a judgment call as to whether several individual programs should be considered 'PES with qualifications', or 'non-PES with PES-like characteristics'. For instance, the SLCP appears not to be voluntary in many regions in which it is applied, and many programs appear to only weakly enforce conditionality. Even among us three editors, there is thus some disagreement over where exactly the line between PES and non-PES should be drawn. Ultimately, however, we feel it is more useful to discuss whether PES programs are well-designed or poorly-designed — a topic we assess in the following sections.

As can be seen in Table 1, there is a clear difference in scale between user- and government-financed programs. Many user-financed programs are for hydrological protection at a small (500–5000 ha) watershed scale. At over 22,000 ha, the PROFAFOR carbon program is an outlier among such programs. Government-financed programs (pilots excepted) are orders of magnitude larger, with even the smallest having 270,000 ha (Costa Rica's PSA) while the US CRP reaches 14.5 million ha. User-financed programs also tend to remain similar in size over time, while government-financed programs often go through an initial pilot phase, followed by an expansion in scale. Thereafter their size tends to vary with annual budget allocations, except when earmarking provides them a reasonably secure funding base.

The other clear difference between the two types of programs is that while government-financed programs typically embrace multiple ES, user-financed programs tend to be focused on a single ES (usually either a water-related service or carbon sequestration). China's SLCP, with its focus on watershed protection, is an exception to this pattern among government-financed programs[7] while Los Negros, with its joint payments for water and biodiversity is an exception among user-financed programs. PES-promoted land uses are generally well-defined in user-financed programs, and so are the corresponding ES. In contrast, some government-financed programs tend to define the multiple ES that they target with much less precision. Yet, the CRP has perhaps the most specific definition of benefits sought, as it assesses applications based on their score on the Environmental Benefits Index (EBI) which includes quantitative measures of expected erosion reduction, water quality, wildlife, and other benefits.

These differences in focus are tied to the differences in scale between user-financed and government-financed programs. Programs financed by individual water users, for example, focus entirely on the areas that supply them with water, and thus inevitably have a limited spatial scale. A focus on a single ES also affects selection of providers, particularly in the case of water services. User-financed programs that seek to generate water services must perforce deal with whatever providers are found in their water supply areas, even if this means dealing with high costs of provision and high transaction costs.[8] In contrast, programs that seek carbon sequestration have the luxury of being able to pick and choose their providers almost anywhere, and can thus seek to minimize both costs of provision and transaction costs.[9] With their much broader focus, government-financed programs also are able to choose among a very broad range of potential suppliers. These programs tend to use this flexibility to pursue non-environmental objectives such as poverty reduction or regional development, as discussed below.

Table 2 summarizes some of the important design characteristics of the PES programs in our sample. Who runs the program is one of the most important of these characteristics. Someone has to act as an intermediary between those who are paying for ES and those who provide them. Working with providers is particularly complex logistically (and accounts for the bulk of transaction costs in a working program), as there are usually many providers dispersed over the landscape. Someone needs to negotiate with them and/or communicate the offered payments, contract with interested providers, monitor compliance, and make payments (Pagiola and Platais, 2007). In user-financed programs, buyers often created their own intermediaries. Government-financed programs are managed by national agencies either created for the purpose (Costa Rica's National Fund for Forest Financing, FONAFIFO,[10] or South Africa's Working for Water, WfW) or already working in the sector (Mexico's National Forest Commission, CONAFOR). In other cases, as in China's SLCP, PES implementation was delegated to lower levels of government — sometimes as an unfunded mandate. Because of their size, government-financed programs tend to have significant economies of scale, compared to the much smaller user-financed programs, as we discuss below. The institutional framework conditions for government-financed PES programs have remained rather stable over time: whatever initial set-up was chosen has tended to persist.

In all but one case (WfW), payments are made to land holders. This hides a very wide variety of arrangements, however, as recipients – even within the same program – can include individuals, cooperatives, and indigenous communities; some holding *de jure* land titles and others *de facto* controlling untitled lands. Security of tenure becomes increasingly important when PES participation requires long-term investments such as reforestation (Pagiola and Platais, 2007). As Engel and Palmer (2008-this issue) have shown, *de facto* control may, however, itself be affected by PES.

Table 3 summarizes the main details of the actual payments in each of our case studies.[11] Direct comparisons of payments are difficult, as socioeconomic conditions differ substantially from case to case, as do the activities that PES program seek to encourage or discourage. Unsurprisingly, PES

[7] Mexico's PSAH is only an apparent exception, as separate government-financed programs targeted biodiversity conservation and carbon sequestration. In 2007, these programs were unified into a single program called Payments for Forest Environmental Services (PSAB), with separate windows for watershed protection, biodiversity conservation, and carbon sequestration.

[8] This also means that many potential user-financed programs for water services may never emerge because of excessive costs in their water supply areas.

[9] Programs that seek to generate Kyoto-compliant carbon credits are limited to areas that were deforested prior to 1990, but this is not a very significant constraint as there are many such areas to choose from.

[10] Costa Rica also relies on several other actors – other government agencies, local NGOs, and private actors like the *regentes forestales* (certified forest engineers) – to accomplish a range of roles.

[11] About half the cases have no cash-payment data, either because auctions were used and the range of payments made were not available, and/or because payments were not made on a per-area basis. Payments listed do not include the value of technical assistance.

Table 2 – Design features of PES case-study programs

Case	Intermediaries	External donor support	Seller selection	Monitoring	Sanctions	Conditionality	Linked to other policy tools?
User-financed programs							
Los Negros, Bolivia	Fundación Natura (NGO)	USFWS as biodiversity buyer/donor	Village focus: high threat+ strategic service site	Yearly site inspection	Temporary PES exclusion (not applied so far)	High in principle — but *de facto* still untested	Local rules on deforestation
Pimampiro, Ecuador	CEDERENA (NGO)	Inter-American Foundation covered start-up costs	Village focus: high threat+ strategic service site	Quarterly site inspection — now deteriorating	Temporary or permanent PES exclusion (applied)	High, lately some decline	Complements weakly enforced Forest Law
PROFAFOR, Ecuador	PROFAFOR (buyer organ)	No	Biophysical conditions, price, minimum size, clusters	Yearly site inspection+ aggregate model	PES payback+land mortgage (applied to individuals only)	High for individual owners, lower for communities	No
Vittel, France	Agrivair (buyer-created agricultural extension agency)	No	All 27 dairy farmers in catchment	Farm inspection (at unknown frequency)	Information not available	High	Compete with EU subsidies for intensive dairy farming
Government-financed programs							
SLCP, China	Village, township and county governments	None	Based on land slope, plot size, retired land contiguity	Frequent by village officials, less by township/ county, random by upper-level government	Withholding of subsidies — but weak enforcement	High for area retired, lower for successful forest plantation	No
PSA, Costa Rica	FONAFIFO (autonomous state agency), with support from SINAC, NGOs, private forest engineers	GEF	Priority areas (currently based on biodiversity and poverty criteria, but water criteria being added)	Compliance monitored by private forest engineers, with sample audited	Loss of future payments	High	Forest Law that created PSA also bans forest clearing
PSAH, Mexico	Water Commission collects, Finance Ministry transfers, Forestry Commission administers	GEF	2003 almost random, 2004 basic grading+ regional balance, 2005 grading in place	Forest cover: yearly satellite image analysis; random (few) site visits	Intentional: current+ future payments cancelled (3 cases in 2 yr) Unintentional (fire etc.): affected area is not paid for	High compliance wrt. forest-cover conservation (water service not monitored)	Reforestation, plantation, and development programs
CRP and EQIP, USA	None	No	Based on environmental benefits and cost index	CRP: Annual inspection of 5% contract sample; EQIP: 17% non-full compliance	CRP: repay with interest, but options to rectify; EQIP: lax enforcement of sanctions	Conservation work needs be completed before payment, but low inspection rate	Cross-compliance with other government payments
ESA and CSS, UK	Government agency (DEFRA)+ NGOs	EU funds supplemented running costs	ESA: open to all (in target areas); CSA: selection	By DEFRA, universities, etc. — low annual sample (5%)	From warnings to exclusion and repayment	Low risk for non-compliers of getting caught	Compete with EU CAP 1st pillar prod. subsidies; cross-compliance

Table 2 (*continued*)

Case	Intermediaries	External donor support	Seller selection	Monitoring	Sanctions	Conditionality	Linked to other policy tools?
Northeim model project, Germany	University of Göttingen, with district authorities	Private foundation — seller/donor role	Tendering procedure	Annual full inspection	Non-payment (annual, ex post)	High	Agri-environment pillars of CAP
Wimmera, Australia	Wimmera Catchment Management Authority	No	All SHC landholders eligible (SHC create more salt loads)	Random (audit style approach) — results publicized (accountability)	Yes — but difficult to enforce in court. Social and cross-compliance may be stronger pressures	Designed as such — but reduced by large upfront payments and low sanction risk	Overlapping mechanisms removed to prevent strategic behavior
PES-like programs							
CAMPFIRE, Zimbabwe	RDCs (in part representing communities)	Substantial: USAID (main) NORAD, DFID	Preferences for large wildlife populations	Wildlife ground counts, aerial and satellite imagery	No, only indirect (when contracts are renegotiated)	Apparently high compliance	Local by-laws; Wild Life Act strengthened
WfW, South Africa	WfW (buyer organ)	No	Previously unemployed people in priority catchments	Works self-supervised by WfW	Not applicable	Clear: payment provided only if clearing work is done	Link to not-yet-enforced laws that require private owners to clear lands of aliens

Sources: See Table 1.

programs that seek to either maintain current uses or take land out of production and leave it idle pay much less than programs that require affirmative actions such as reforestation. In the former case, it is sufficient to compensate providers for the opportunity cost of foregoing higher-return alternative land users. In marginal areas, this is potentially very low, as shown by the very small payments in Los Negros and Pimampiro. When reforestation is required, however, providers must be compensated not only for the opportunity cost, but also for the cost of planting trees. Thus PSA pays US$45/ha/yr for forest conservation, but US$163/ha/yr for timber plantations.[12]

In practically every case, payments are based implicitly or explicitly on the cost of ES provision, rather than on the value of the ES. Thus programs that are nominally paying for multiple ES, such as Costa Rica's PSA, do not pay more for similar activities than programs paying for a single ES, such as Mexico's PSAH. Indeed, the Los Negros program, which is nominally paying for both water services and biodiversity conservation (through a contribution from the US Fish and Wildlife Service), has some of the lowest payments of any program in our sample.

Although cash is the most common form of payment, it is often supplemented by technical assistance (TA) and in-kind compensation (such as provision of seedlings in programs calling for reforestation).[13]

There is a sharp contrast in the use of differentiated payments between user-financed and government-financed programs, particularly those in developing countries. Payments are at least moderately differentiated in all our user-financed cases — Los Negros has no less than six different payment categories in its 2800 ha area, while Vittel developed plot-level customized pricing for participants. In contrast, government-financed programs often pay uniform rates countrywide — often due to equity concerns[14] and administrative ease. Some developed-country programs, however, have high implicit differentiation through their use of reverse auctions, as in the CRP and in Wimmera. Although individual agri-environment programs in the EU often have little differentiation, this is partly compensated by the large number of such programs, most of them tailored to conditions in particular regions.

In all cases, payments are at least nominally conditional. In reality, conditionality is generally lower in government-financed programs than in user-financed programs, but variable between programs — and even within programs over time (*e.g.*,

[12] The timber plantation figure is an average of the total payment of US$816/ha, which is paid out over 5 yr, with 50% front-loaded in the first year. Farmers are also expected to benefit from the sale of the timber at the end of the 15–20-yr rotation, and from sales of timber from periodic thinning of the plantation in the interim.

[13] In Los Negros, providers elected to take their payment in beehives (in-kind transfer combined with technical assistance). Their prime motivation was that this type of "contingent project assistance" by the NGO would provide more lasting returns than cash transfers, due to limited local investment opportunities.

[14] Although, as Ferraro (2008-this issue) shows, equal payments do not necessarily imply equity.

Table 3 – Payments to providers in PES case-study programs

Case	Mode of payment	Payment amount, cash equivalent (US$/ha/yr)	Timing of payment	Differentiation (spatial, other)	Contract duration
User-financed programs					
Los Negros, Bolivia	In-kind + TA	1.5–3.0	Annual, *ex ante*	Higher for cloud forest and primary vegetation	Variable length (1+ yr)
Pimampiro, Ecuador	Cash	6–12	Monthly, post-monitoring	Higher for primary vegetation	Initially 5 yr, now unlimited
PROFAFOR, Ecuador	Cash + in-kind + TA	100–200 (up front)	Years 1–3 plus tree harvests	Yes, site-level negotiation	15/20/99 yr
Vittel, France	Cash + TA + agricultural labor costs + land rent	300 for 5 yr up to 225,000/farm cost reimbursements	NA	Yes, on farm-by-farm basis	18–30 yr
Government-financed programs					
SLCP, China	Cash + grain (phased out), + free seedlings + TA	Cash: 36; Total cash equiv. 217–308 (2005); *de facto* lower and highly variable	Annual, normally	Higher in Yangtze River than Yellow River Basin	Max. 8 yr for timber, 5 yr orchards, 2 yr grassland
PSA, Costa Rica	Cash	45–163	Annual, after monitoring compliance	No	5-yr forest conservation (renewable), 15-yr timber plantation
PSAH, Mexico	Cash	27–36	Annual, ex post	Higher for cloud forests	5 yr (conditional renewal)
CRP and EQIP, USA	Cash + TA	Variable	Annual; post-adoption (EQIP)	Yes, site-level bids and environmental index scores	10–15 yr
ESA and CSS, UK	Cash	ESA: 20 (2003) CSS: 16 (2003)	Share of initial capital costs; annual payments	Yes, multi-tier	1–10 yr
Northeim model project, Germany	Cash	Variable	Annual, ex post	Yes, through tendering and model-sites selection	10 yr
Wimmera, Australia	Cash	Variable	Large upfront payment	Yes, reverse auction	1 yr
PES-like programs					
CAMPFIRE, Zimbabwe	Cash to RDC; mostly in-kind to communities	NA	Annual to RDCs, delays often to communities	Yes, quality of hunting/eco-tourism sets auction price	1–7 yr, conditional renewal
WfW, South Africa	Cash	Not area-based	Paid ex post, contract-based	No	Programs last 10 yr

Notes: NA = Not available.
TA = Technical assistance.
Sources: See Table 1.

CRP). In small user-financed programs, conditionality may be limited by monitoring capacity, as in the case of Pimampiro. In government-financed programs, it may be limited by an apparent unwillingness to penalize non-complying participants, who may be politically powerful (in developed countries) or poor (in developing countries). When opportunity costs are low, as in

Los Negros, the extent to which conditionality is enforced may remain largely untested. When programs require reforestation, payments must often be front-loaded to help farmers finance the required investment, which reduces conditionality.[15]

Overall, we can say that user-financed programs show greater adherence to a pure PES definition, and are more targeted in their effects (see discussion below), compared to the larger, multiple-objective, government-financed programs that often have broader and less well-defined objectives. Indeed, the latter can sometimes be hard to distinguish from more traditional subsidy programs, the main differences coming in the conditionality of payments.

3. Effectiveness and efficiency of PES programs

In the theoretical literature on PES, it has been suggested that the direct nature of the PES transaction induces PES to be both more effective and more cost-efficient than indirect tools such as ICDPs or eco-friendly premiums requiring investments in alternative lines of production (Ferraro and Kiss, 2002; Ferraro and Simpson, 2002, 2005). In this section, we examine how effective PES programs have been at achieving their stated objectives of improving ES generation. We also examine the cost at which these ES have been generated, and analyze the programs' cost effectiveness. Unfortunately, in all cases the data available to address these questions are incomplete.

3.1. *Environmental service generation*

Whether a PES program succeeds in generating the desired ES depends on a series of questions. First, potential service providers must enroll in the program. Any ES provision by non-participants cannot be attributed to the program. Second, providers must comply with the terms of their contract. This requires that there be some means to monitor compliance, as well as penalties for non-compliance. Third, compliance must result in a change in land use compared to what would have happened without the program. If PES recipients would have undertaken the exact same land uses even without payments, no additional ES will be generated (the 'additionality' problem). Fourth, the induced land-use changes must in fact generate the desired ES. As the linkages between land use and ES are often uncertain, this cannot be taken for granted. Beyond this, several other issues are important: whether the desired ES are provided on a long-term basis ('permanence'); whether the environmentally-damaging land uses that the PES program is replacing are displaced elsewhere ('leakage'); and whether the program creates perverse incentives. We examine the available evidence on each of these factors in our case-study PES programs in turn. Table 4 summarizes relevant factors from each case.

Enrolment. Most of our PES case studies had little difficulty in attracting potential ES providers. Indeed, in most cases applications far exceeded the available funding — by a factor of three in both Costa Rica's PSA and Mexico's PSAH, for example. The main exception here concerns some of the smaller user-financed programs, which sometimes had to deal with considerable mistrust, as in the case of Los Negros.[16] Even where participation is high overall, however, it may not be high in the most important areas. Despite their very high application rates, for example, both the PSA and PSAH programs had important gaps in their coverage in areas of high-value water services. The most likely reason for these gaps is that opportunity costs in these areas exceed the uniform prices that these programs offer. This is an example of one of the sources of inefficiency in PES programs noted by Pagiola (2005): offering payments that are insufficient to induce socially-beneficial activities. PES programs with uniform pricing are particularly vulnerable to this problem, as their prices also tend to be low. In general, the most important issue concerning participation is whether the right potential providers are participating. We return to this issue below.

In our sample, payments are rarely tied directly to measured ES units.[17] Rather, payments are tied to proxies — almost always area under approved land uses, though some programs use mixed standards, such as area reforested combined with a minimum tree-survival rate. Although basing payments on actual ES delivery would seem obviously preferable, payments cannot be based on variables that ES providers cannot observe (Pagiola and Platais, 2007). Farmers, for example, have no way of observing how their land-use practices affect water ES delivery far downstream.[18] It is not surprising, then, that closely measured ES delivery is most common in carbon sequestration, such as the PROFAFOR project.[19]

Compliance. Ensuring that PES recipients comply with their contracts requires appropriate monitoring. All our case-study programs monitor compliance through site inspections — in the case of the larger programs, through remote-sensing satellite imagery coupled with sample site inspections. The quality of monitoring can vary over time depending on funding, particularly in the smaller programs where these costs represent a larger share of expenditures. Even developed-country programs

[15] In principle, upfront payment could still be conditional in the sense that contracts could stipulate that the payment has to be repaid in case of non-compliance. In practice, however, such provisions are often unenforceable due to weak legal systems, high transaction costs of enforcement, and poverty considerations.

[16] Potential participants were in part skeptical that payments would be forthcoming, and in part fearful that the program was a cover for land appropriation. The first concern can be alleviated by actually making payments, including, if necessary, a nominal *ex ante* payment. The second concern is harder to address, but may abate over time.

[17] PES programs where providers are paid directly according to measured ES units delivered do exist, but they are exceptions rather than the rule. One example is the Swedish payments for wildlife conservation based on measuring carnivore offspring (Zabel and Holm-Müller, accepted for publication).

[18] There are exceptional circumstances in which this may not be true. The payments for hydrological services by Costa Rican hydroelectric producer La Manguera SA are computed using a formula based on its ability to generate power (Rojas and Aylward, 2002). This arrangement is possible because the entire watershed above its plant is owned by a single landholder.

[19] In the PROFAFOR case, ES delivery is measured in sample plots, but payment decisions are still based on land-use proxies (plantation establishment and tree-survival rates).

Table 4 – Factors affecting effectiveness and efficiency of PES case-study programs

Case	Baselines and scenarios	Opportunity costs	Additionality	Land use–service link	Leakage	Permanence	Transaction costs (US$)	
							Start-up	Recurrent
User-financed programs								
Los Negros, Bolivia	Implicit — declining natural vegetation	Not studied	Probably low, as low-threat areas are enrolled	Assumed, not proven	Low; some at on-farm level	Not secured beyond contract period	46,000 (17/ha)	3000/yr (1/ha/yr)
Pimampiro, Ecuador	Implicit future scenario — likely decline in natural vegetation	Not studied	High, for land use: clear trend change towards conservation	Assumed, not proven — likely in part	Zero; no effect displaced within watershed	Not secured beyond contract period	37,800 (76/ha)	3600/yr (7/ha/yr)
PROFAFOR, Ecuador	Explicit — static land use	Only labor costs known	High (vis-à-vis baseline)	Explicit	Low — some livestock substitution	Not secured beyond contract period	4.1 million (184/ha)	76,600/yr (3/ha/yr)
Vittel, France	Explicitly modeled (4 yr of research), declining ES	Studied, large in size, fully compensated	High, clearly improved water quality	Explicit at plot level	Zero	Not secured beyond contract period	Not divided up	Total costs (incl. payments) 1993–2000 24.5 million (600/ha/yr)
Government-financed programs								
SLCP, China	Implicit	Only roughly known	High for land retirement; lower for reforestation	Assumed so far — ongoing research to quantify	Barely studied, but one survey suggests leakage does occur	Not secured beyond contract period, but estimated at about 60%	NA	NA
PSA, Costa Rica	Explicit static forest-cover baseline	Not studied, but implicitly based on extensive grazing	Unclear — studies give widely divergent results	Explicit, good research on impact of aliens on water runoff	Low	Not secured beyond contract period	NA	7% of payments (limited by law); some costs pushed onto providers
PSAH, Mexico	Explicit static forest-cover baseline; threat area modeling	INE estimated distribution of opp. costs in target areas — payment > than 30% of distribution	Unknown — but evidence that some low-threat areas are offered	Extensive research, but not explicitly modeled	Not yet tested. Within villages, depends on % of area under contract	Scheme renewal uncertain; hoped-for transition to timber forestry + some local PES	NA	4% of payments (limited by law)
CRP and EQIP, USA	Implicit, variable shape	Not known — to be revealed in part by bidding	Not researched	Explicit, thresholds well-documented	For CRP, estimates vary from small to 21%	Not secured beyond contract period — but estimated at 49% for CRP	High investment in geo-referenced EBI system	CRP: 15.5 million (2005); <1% of CRP transfers (+research costs)
ESA and CSS, UK	Implicit, static baselines	Calculated for model farms (labor and capital costs)	Significant effect on ag. margins — little on prime ag. lands	Modeled, service provision estimated	Some on-farm leakage; little in the larger landscape	Low (CSS: two thirds recipients reapply)	Not separated out	ESA (England), 1992/3–1996/7: 18% admin. costs (start-up + running)

Table 4 (*continued*)

Case	Baselines and scenarios	Opportunity costs	Additionality	Land use–service link	Leakage	Permanence	Transaction costs (US$)	
							Start-up	Recurrent
Northeim model project, Germany	Implicit, declining: intensification or abandoned cultivation	Not known — to be partly revealed by tendering	Probably high, as participants' extensive ag. practices decline	Explicit, thresholds well-documented	Not available	Not secured beyond pilot phase, but targeted at CAP	NA	NA
Wimmera, Australia	Explicit, static (minimum duty-of-care scenario)	Not known — to be revealed in part by auction	Designed high: ES outcome-oriented targeting	Modeled — ES provision estimated	Negligible risk predicted	Not secured beyond contract period — but some changes may last	High, due to pilot nature of scheme (65,000–100,000)	High, due to pilot nature (33–465,000/yr)
PES-like programs								
CAMPFIRE, Zimbabwe	Implicit	Not studied, but positive	Marked rise in wildlife population and hunting revenues	Explicit: wildlife habitat dependence	Limited, since prime wildlife areas are targeted	Not secured, but changed local attitudes to wildlife	NA	1989–2001: 3.7 million (12.1%, 0.07/ha/yr)
WfW, South Africa	Implicit, but more exotics (ES decline) is likely	Known labor opportunity costs (small); land opp. costs negative	High, demonstrated improved runoff	Extensive research, but not explicitly modeled	None	Not secured beyond contract period, but some lasting changes	NA	70 million/yr (total clearing costs + social program, admin. + research

Sources: See Table 1.

can have limited monitoring, however, if they choose not to devote resources to it. Thus some agri-environmental programs of developed countries have very low annual inspection rates of only about 5%.

Monitoring by itself is not sufficient to ensure compliance unless non-compliance is sanctioned. In most case studies, the primary sanction for non-compliance is the loss of future payments, either temporarily or permanently. In some cases, previous payments have to be repaid. Developed-country government-financed PES programs also typically include cross-compliance provision that ties eligibility for other subsidy programs to compliance. In principle, more severe sanctions could reduce monitoring costs by raising the expected losses from non-compliance, but such sanctions may be both politically and practically difficult to enforce. Indeed, some programs hesitate to employ even the simple sanction of withholding future payments. We are aware of no systematic study of the degree to which different types of sanctions have proved effective at inducing compliance.

Additionality. Even assuming compliance, a PES program will only result in an increase in the provision of ES if it induces a real change in the targeted land-use actions.[20] Landowners may be maintaining forest on their land (as required by their contracts), but if they would have done so even in the absence of payments, the extent of ES provided will be unchanged. In practice, measuring additionality is difficult, as it requires comparing the observed 'with-intervention' behavior with an un-observed 'business-as-usual' counterfactual scenario. Only one PES program, to our knowledge, has incorporated a detailed and systematic effort to formally quantify additionality of various ES provided using *ex ante* scenarios.[21] This is regrettable, but not unusual, as no other conservation program does so either (Ferraro and Pattanayak, 2006).[22] There have been efforts to assess additionality in PES programs, but they have all been ex post. Several such studies have been undertaken in Costa Rica, for example, with widely divergent results, ranging from practically no impact of PES on deforestation (Sánchez-Azofeifa et al., 2007) to a 10% increase in primary forest cover (Tattenbach et al., 2006). This is an area in which additional research is urgently needed — ideally with ap-

[20] It should be noted that not all PES programs require additionality of their participants. Costa Rica's PSA, for example, explicitly does not and would in principle pay every landholder with forest cover if funds were sufficient.

[21] The Regional Integrated Silvopastoral Ecosystem Management Project, financed by the Global Environment Facility (GEF) and implemented by the World Bank, included a control group of non-participants whose land-use changes were monitored along with those of PES recipients. An analysis of the impact of payments at the project's Quindío (Colombia) site showed that PES recipients changed significantly greater shares of their farms and made significantly more intensive changes (Pagiola and Rios, 2008).

[22] Additionality is an explicit condition for eligibility of carbon sequestration activities for sales of emissions reduction credits under the Kyoto Protocol's Clean Development Mechanism (CDM). However, no CDM-compliant project was included in our sample, as they are too new — indeed, as of this writing only a single such project has been registered by the CDM.

propriate monitoring measures built into the design of the PES program from the outset.

From anecdotal evidence, a reasonably good case can be made for saying that many user-financed programs probably have had high additionality. In Pimampiro, for example, previous deforestation trends were reversed in the program area, but continued apace in surrounding areas. The exception here is Los Negros, as most enrolled plots at this early stage of implementation are found in low-threat areas. In general, additionality is easier to establish in programs that require explicit land-use changes, such as reforestation. Although it is possible that reforestation would have occurred even without payments, such land-use changes are often rare outside program areas. For example, PROFAFOR succeeded in establishing 22,300 ha of plantations on degraded lands in Ecuador, while a variety of traditional subsidy-based reforestation programs elsewhere in the country failed to achieve significant results.

Link between land use and ES. Additionality in land use still is not sufficient, however. We also need to know that the *right* land-use changes are being undertaken — that is, land uses that generate the desired ES. For carbon sequestration projects such as PROFAFOR, the link between land use and ES is generally well established, and can easily be monitored in the field.[23] For biodiversity focused interventions, protecting or restoring the original habitat will normally produce positive effects, although their size is variable. Landscape values are aesthetically determined, and thus valued directly through user perceptions, without any apparent need for scientific monitoring. However, for watershed programs like Pimampiro or Los Negros, whether PES programs are promoting the right land uses is less clear, as the underlying biophysical linkages have been little measured and are the subject of considerable controversy (Bruijnzeel, 2004; Calder, 1999; Chomitz and Kumari, 1998).[24] Many programs have been content to blithely assume that forests, in particular, provide all desired ES. Even where *ex ante* efforts were made to assess linkages between land use and water services, as in Mexico, these were often stymied by lack of data. South Africa is an exception here, as the relationship between invasive alien species and water use has been well-documented. In general, however, it is quite likely that, in at least some areas, PES programs are promoting the wrong land uses for the ES they desire — for example, by increasing forest cover in areas with water deficits.

The situation is not altogether bleak, however. First, in many cases where landscapes are currently in near-natural conditions and services are satisfactory, there is a strong case to be made for conservation based on the precautionary principle — particularly as preventing adverse land-use changes, as noted previously, would be much cheaper than restoration efforts. Many payments by individual water users in Costa Rica, for example, are explicitly based on this logic. Second, although the links between land use and some water services are uncertain (notably, dry-season water supply), others are much better established. Water users do not want a generic water service but usually a very specific one; hydroelectric power producers, for example, worry about sedimentation, but not about other forms of contamination. As links between land use and erosion are reasonably well established, it should often be possible to design appropriate PES programs in this case.

Nevertheless, at present it is fair to say that many PES programs are based on a shaky scientific foundation. Unfortunately, the lack of monitoring of ES generation makes it difficult to detect problems and react to them. It would be reasonable to expect user-financed programs to fare much better in this regard, over the long turn. First, users have their own money on the line, and thus a strong incentive to ensure it is spent effectively. Second, the much smaller scale and narrow ES focus of these programs makes it easier to observe whether the desired ES are being generated or not. Indeed, perhaps the clearest evidence of a PES program succeeding in generating the desired services is in the case of water bottler Vittel, where a clear improvement in water quality was measured after the program's implementation.[25]

Permanence. That a PES program is generating ES at a given point in time does not guarantee it will do so over the long term. While a PES program is in effect, continued ES provision is likely to depend primarily on continued financing of the program. In user-financed programs, this depends on the users being satisfied that they are receiving the ES they desire,[26] which underlines the importance of ensuring that PES programs 'get the science right' and actually deliver ES (Pagiola and Platais, 2007). In government-financed programs, it depends on continued budget allocations. Even while the program is in effect, changing conditions may cause participants to reconsider their participation and exit the program (either by not renewing their contracts, or by violating its terms). If the potential benefits of alternative activities increase, PES programs will have to increase their payments if they wish to continue attracting participants (equally, though, if the benefits of alternative activities decrease, PES programs may be able to offer lower payments and still retain participants). Most PES programs have been in operation for too little time, however, to have had to confront this problem on a large scale. Programs that base payments on bids from participants, like the CRP, are likely to be able to respond more flexibly to exogenous changes in conditions, as applicants will take them into consideration when making their bids. Programs which offer fixed payments (particularly uniform payments) will likely face politically difficult decisions when conditions change.

Considerable concern has also been expressed by some as to whether the benefits of PES programs would continue once payments end (Swart, 2003). If the externality underlying PES is permanent, as for instance will apply to most cases of forest

[23] Even here, however, some controversy developed around soil-carbon release from forest plantations in some highland areas.

[24] There are often strong local beliefs about the role of forests in providing water services, and these can prompt the establishment of PES programs even when scientific evidence is lacking, as in Los Negros and Pimampiro.

[25] Note that this before-and-after comparison could be due to exogenous factors. Only a with-and-without comparison can formally attribute the impact to the PES program. However, in this particular context exogenous trends were pushing very much in the opposite direction.

[26] In Costa Rica, several water users who are paying for conservation in their watersheds have renewed their contracts to do so.

conservation, there is no reason to believe that a service will be provided after payments end. The limited available evidence suggests that permanence of benefits after payments end is probably low in most our sample cases. An exception is the CRP, where land-retirement permanence is estimated at a high 49%.[27] Programs that focus on planting trees, such as PROFAFOR or SLCP, base expectations of permanence beyond the end of payments on the expected benefits from the timber harvest. This may hold true for the current harvest cycle, but participants are unlikely to then replant without further payments. Other programs explicitly use short-term payments on the premise that the practices being supported are privately profitable once established, and thus will be retained.[28] One may question, however, whether the complications of a PES program are justified in such cases, and whether more traditional agricultural support and credit programs would not achieve the same result. This lack of permanence is due to the nature of the problem being addressed, however, and cannot be taken as a direct sign of environmental inefficiency of a PES program. On the contrary, the persistence of PES-promoted land uses after the end of payments could be taken as indication that the payments did overall not result in any additionality (Pagiola and Platais, 2007).

Leakage. Successful ES generation may be undermined to the extent that environmentally-damaging activities are merely displaced rather than reduced, a problem known as 'leakage' (or, sometimes, 'spillage'). Leakage can occur at the local level (*e.g.* a PES recipient clearing one plot of land to substitute for another under conservation contract), or indirectly at a broader level (*e.g.* if maintaining forest results in higher crop prices due to the reduced availability of cropland, which induces additional deforestation elsewhere). Leakage is only relevant when the spatial scope of intervention is lower than that of the desired service. By definition, leakage will thus always be a relevant concern for global services like carbon storage. For more localized services, whether leakage is a concern will depend on the scale of intervention (*e.g.*, whether the entire watershed is included, or only part of it): displacing erosive land uses to areas where they do not affect water services, for example, would not negate the benefits of a PES program.

In practice, little is known about leakage, because it is hard to calculate reliably — the only quantitative estimate in our sample being the maximum estimate for the CRP of 21% (Wu, 2000). Some studies cite anecdotal evidence of local leakage. With careful design of contracts and appropriate monitoring, the risk of local leakage can be reduced.[29] Indirect leakage is harder to assess and deal with. Given their small size, most user-financed PES programs are very unlikely to induce indirect leakage effects, but government-financed programs, with their much larger scale, do have this potential. Ross et al. (2006) use a CGE model to estimate induced impacts of Costa Rica's PSA and find minimal effects — a particularly significant finding, as the PSA program is one of the largest in relation to the size of the economy. The limited qualitative evidence from our cases reinforces the intuitive evaluation by others (*e.g.*, Chomitz, 2006) that the perception of widespread leakage is often exaggerated. In particular, in landscapes with extensively used areas, intensification options may exist that avoid significant spatial transfers of pressures. In addition, many non-carbon programs target their intervention sufficiently widely in space to reduce the risk of significant leakage. Yet for carbon services, leakage is bound to remain a high concern, and can only be counteracted by programs covering large spatial areas.[30]

Perverse incentives. Finally, PES programs need to be careful not to create perverse incentives, the classic example being that offering payments for reforestation could induce deforestation. PES programs that stress additionality are particularly at risk of creating perverse incentives — if payments are offered only when there are clear threats of degradation, then potential applicants may be induced to create such threats (Pagiola and Platais, 2007). This can sometimes be avoided by careful contract design. For example, to avoid inducing deforestation, the CDM specifies that only areas deforested prior to 1990 would be eligible to sell carbon credits from reforestation. Of course, PES can also create benign incentives. For example, if cutting down forest is an irreversible decision that extinguishes the option of receiving payments in the future, even non-participants may retain forests. The existence of the PES program could thus be said to be creating an option value for the forest. Tattenbach et al. (2006) argue that this effect has been significant in Costa Rica.

3.2. *Cost of ES provision in PES programs*

PES efficiency is not only determined by the extent to which incremental ES are provided, but also by the cost at which this was achieved. These costs include: (a) the opportunity cost of the benefits foregone from alternative activities; (b) when land-use changes are required, the implementation cost of making and maintaining those changes (*e.g.*, reforesting or *in-situ* forest monitoring); and (c) the transaction costs of the program. Many discussions of the efficiency of PES programs focus on the amounts paid, but it is important to stress that the payments themselves are *not* a social cost — they are a transfer, which cancels out in calculations of social welfare (Pagiola, 2005). However, as opportunity costs are generally not observable, payments can be used to make at least some order-of-magnitude estimates. If we assume that participants are rational decision-makers, then they would be unlikely to accept a payment unless it exceeded the sum of the

[27] We would expect, however, that recent increases in food prices will have a significant negative impact on this figure, as well as on participation in the CRP itself.

[28] The Regional Integrated Silvopastoral Ecosystem Management Project used this approach. It is too early to tell the results, but indications are that permanence holds in some cases, though not necessarily for some of the environmentally most desirable practices (Pagiola et al., 2007a).

[29] For example, the Regional Integrated Silvopastoral Ecosystem Management Project monitored land-use changes in the entire farms of participants, and withheld payments if any part of the farm switched to environmentally more damaging activities (Pagiola et al., 2007a).

[30] Thus the Forest Carbon Partnership Facility, which is planning to pilot payments for avoided deforestation, plans to monitor changes in carbon stocks at the national level (B. Bosquet, pers. comm, 2007). Even this may not be sufficient: unless a significant share of countries participate in a carbon reduction commitment, there could be significant leakage from one country to another (Murray, in press).

opportunity costs they face, any implementation costs they must undertake, and any transaction costs they bear.[31,32] Payments can thus be taken as an upper bound to these values. By adding transaction costs borne by the PES program itself (and, where relevant, other costs such as deadweight costs when financing are generated through taxation), we can arrive at a reasonable upper bound of the total costs of the program.

Transaction costs. We discussed payment levels earlier (Table 3 above). We turn here to a discussion of PES transaction costs. We define transaction costs as a residual: all those costs that are not payments proper. Transaction costs occur for two reasons. First, because informational needs have to be satisfied for PES to function: land use–ES linkages need to be assessed, baselines have to be established, and compliance by participating providers has to be monitored, for example. Second, the logistical costs of actually undertaking PES transactions must be borne. It is useful to distinguish between start-up costs that must be borne before the program is functioning (including information procurement, program design and negotiation costs) and recurrent costs of implementation (monitoring, sanctioning, payment administration, etc.) (Cacho et al., 2005; Pagiola and Platais, 2007).

Available data on transaction costs in our case-study programs are shown in Table 4. Except for Costa Rica, we do not have estimates of transaction costs borne by service providers. In any case, however, these costs are already subsumed in payments, as argued above. We focus, therefore, on transaction costs borne by the PES program itself. These transaction cost data must be interpreted very carefully, for many reasons. First, they are not always fully comparable, since some costs (for example, research on land use–ES links) are sometimes conducted by third parties or are paid for under different budgets. Second, apparently low transaction costs may result from under-spending for monitoring or other important activities. A cheap program might also be an ineffective one, but the shortcomings may not be visible until later. Conversely, high costs are not proof of effectiveness, as money can be spent inefficiently.

With these caveats in mind, the data in Table 4 suggest that PES programs typically face relatively high start-up costs, and fairly low recurrent costs. Establishing ES baselines scenarios, revealing linkages between ES and land use, and negotiating the PES system can be time-consuming and costly. Many of these costs are likely to be fixed minimum costs, rising less-than-proportionally with scale, and thus are particularly high in relative terms in the smaller user-financed programs. Start-up costs were about US$76/ha in Pimampiro, US$184/ha in PROFAFOR, and over US$4800/ha in Vittel, for example.[33] These start-up costs consumed amounts corresponding to about 10 yr of payments proper. Obviously, this can only be sustained either by external donors subsidizing start-up costs, as happened in Pimampiro and Los Negros, or by very high-value ES, as in the case of Vittel. However they are financed, such high start-up costs may put into question whether these mechanisms are socially efficient in cases where ES are not of very high value. Finding ways of reducing the start-up costs for small PES mechanisms remains a major challenge. The corresponding recurrent costs in these programs are typically one or more orders of magnitude lower; as little as US$1/ha/yr in Los Negros and US$3/ha/yr in the case of PROFAFOR. In comparison, the government-financed PES programs benefit from their larger spatial scale, and often also from pre-existing public-sector institutions with regional coverage, which help them keep transaction costs down.[34] Considering the many drawbacks of these programs, this is actually a weighty efficiency argument in their favor.

To the extent that some government-financed programs may achieve these low transaction costs by offering untargeted, un-differentiated 'one-size-fits-all' payments without monitoring that ES are actually being generated, however, this cost efficiency advantage is negated. Wünscher et al. (2008-this issue) show that improved targeting, combined with differentiated payments, could significantly raise cost efficiency. Specifically, for a fixed budget, ES delivery could be nearly doubled if applications were selected according to (i) ES provision levels, (ii) risk of ES loss in the absence of PES, and (iii) landowners' costs of ES provision.[35] They demonstrate that doing so need not elevate the program's recurrent transaction costs significantly. Currently, few PES programs take all of these criteria into account, although some take various of them into account.[36] For example, the CRP bases enrolment decisions on the ratio between the expected benefits of a given plot (computed using the Environmental Benefits Index) and the cost of provision (as reflected in the applicant's bid for that plot).[37]

[31] Kosoy et al. (2006) present evidence from Central America that suggests payments are less than the opportunity cost of alternative land uses. This would certainly be a compelling result if confirmed, but the authors themselves present a long list of reasons for this result being spurious.

[32] This obviously can only be assumed when participation is voluntary. When it is not, as in parts of the SLCP, payments may well be less than opportunity costs, as indeed sometimes appears to be the case.

[33] Start-up costs at Los Negros were lower during the first 2 yr (US $17/ha), but only because baseline studies, hydrological modeling, and many other initial costs were postponed until after payments had started. The figure for Vittel expresses total costs, but start-up costs accounted for the highest share of those costs.

[34] Both Mexico and Costa Rica limit the administrative costs of their PES programs by law (to 4% and 7% of payments, respectively). Thus their estimated transaction costs are somewhat artificial. Activities whose costs do not fit into this cap may be postponed or undertaken at lower than optimal levels, if external funding cannot be found to pay for them. Conversely, if a decision is made to increase payments (as occurred in Costa Rica in 2006, for example), budgets automatically expand in direct proportion to the increase.

[35] Similarly, Alix-García et al. (2004) find that targeting Mexico's PSAH with similar criteria could as much as quadruple ES benefits. The higher impact in Mexico is likely due to its higher deforestation rates compared to Costa Rica.

[36] As discussed above, clearly identifying land use-ES links is difficult, thus limiting the ability to target ES provision levels. Estimating opportunity costs for individual landowners or sites is also difficult. Ferraro (2008-this issue) highlights three potential ways to overcome this informational problem: (i) acquire information on observable landowner attributes that are correlated with compliance costs; (ii) offer landowners a menu of screening contracts; and (iii) allocate contracts through procurement auctions. The US and Australian programs are using the auction approach, but in developing countries this tool has barely been used so far.

[37] The Australian bush-tender program (Stoneham et al., 2003) uses a similar approach.

At this point, the data are simply insufficient to determine whether PES programs have lower transaction costs than traditional conservation approaches. Certainly the high start-up costs experienced in some programs are sobering. It is possible that these costs can be reduced through experience, however. It should also be stressed that only part of the high initial costs are truly specific to PES (*e.g.*, negotiation and contract development), while others are common preconditions for almost any conceivable conservation action (Wunder, 2008b). A regulatory approach, for example, would also have to determine which land uses provide which ES in order to ban or compel the correct land uses, and would also need to monitor compliance. Such approaches would only be cheaper if they did not spend many resources on initial assessments of land use–ES links (in which case, they are likely to be inefficient) and if they are not, in fact, enforced (in which case they will be ineffective). It should also be borne in mind that opportunity costs do not become magically smaller if a different approach is adopted. Ultimately, if an environmentally-preferred land use is less profitable to land users than another, environmentally-harmful one, there are only two choices: land users must either be compensated, somehow, for the difference, or they must be forced to absorb it themselves. The lesson here is that conservation *per se* can be costly, not that PES is causing it to be costly.

4. Distributional impacts of PES programs

Although the primary objective of PES programs is to improve the provision of ES, many programs also have additional objectives, as shown in Table 5. In this respect, the differences between user-financed and government-financed programs are striking. While all four user-financed programs have no side objectives,[38] all government-financed programs (except for the Wimmera and Northeim experimental pilots) have at least one and often many more additional goals. While these are explicit in some cases, most frequently they remain implicit — which does not make them less powerful criteria for the allocation of resources.

The most common side objectives are poverty alleviation, regional development, and employment creation.[39] Biodiversity conservation, to the extent that it is not an explicit objective, is often an implicit (but usually free-riding) side objective. There are two broad reasons for the prevalence of side objectives in government-financed programs. The first is that including side objectives is necessary to secure political support for the programs. To this extent, these side objectives can be considered a ‘cost of doing business’. The second set of reasons is that these side objectives are essentially parasitic or rent seeking. Many side objectives in Mexico’s PSAH program, for example, were added after the program was created, either to placate politically powerful groups or to address other government objectives for which funds were insufficient. In these cases, side objectives are much less likely to be benign. In both cases, however, an

Table 5 – Side objectives and welfare effects on poor service providers of PES case-study programs

Case	Side objectives	Welfare effects on poor sellers
User-financed programs		
Los Negros, Bolivia	None	Small, through diversified income (bees)
Pimampiro, Ecuador	None	Higher income and spending
PROFAFOR, Ecuador	None	Higher income + tree assets, investments
Vittel, France	None	Small farmers assured to keep their farms (land purchases)
Government-financed programs		
SLCP, China	Poverty reduction, grain subsidies, timber production	No explicit targeting, does reach the poor, but low income effect
PSA, Costa Rica	Poverty reduction	Positive, but magnitude unknown
PSAH, Mexico	Implicit but weighty biodiversity and poverty criteria	PES can yield up to 10% of their total income
CRP and EQIP, USA	Reduce agricultural commodity supply, support prices and farmer incomes	CRP: poor not targeted, but strongly over-represented in CRP sample
ESA and CSS, UK	Not explicit — implicit farmer-income support, cultural landscape values	Positive, but large farms had more landscape fitting criteria
Northeim model project, Germany	None	Not available
Wimmera, Australia	Explicitly — none	Not available
PES-like programs		
CAMPFIRE, Zimbabwe	Empowerment, local capacity building	Moderate, non-cash (improved services)
WfW, South Africa	Poverty alleviation employment creation	Employment; training; health and education programs

Sources: See Table 1.

[38] The only exception to this pattern is if one considers a desire for a good relationship with ES providers to be a side objective. Note that commercial buyers may sometimes indicate that they have side objectives, but not follow through. For example, although many investors in the World Bank’s BioCarbon Fund were interested in carbon projects that also generated biodiversity ‘co-benefits’, none was willing to pay any kind of premium for such projects (B. Bosquet, pers. comm., 2007).

[39] This is another respect in which South Africa’s WfW differs from the other PES programs. In many respects, it is ES delivery that is the side objective in WfW, with employment creation being the primary objective. Indeed, the bulk of funding for WfW comes from the country’s poverty alleviation budget.

overload of side objectives – or side objectives which come to be more important than the primary objective of ES provision – can end up undermining the PES program. Grain-based payments in the Chinese SLCP were designed to help government reduce costly grain stocks, but proved an impediment to PES functionality. In Mexico, efforts to spread payments 'fairly' throughout the country meant that a substantial share of funding went to area at little risk of deforestation and/or with limited or no threats to water supplies.

One of the most common side objectives is that of increasing the welfare of poorer members of society. There is a growing literature on the links between PES and poverty (Landell-Mills and Porras, 2002; Kerr, 2002; Pagiola et al., 2005; Grieg-Gran et al., 2005; Wunder, 2008a), although the quantitative-empirical basis for assessing results often remains quite limited (Engel et al., 2008-this issue).

Looking first at the four user-financed programs, it is notable that in all cases poor service providers were able to access the program and become ES sellers, and in all cases they also experienced some welfare gains from their participation. This happened in spite of the fact that none of them used poverty-targeting mechanisms, indicating that targeting the poor explicitly is not a necessary condition for PES to benefit them.[40] For government-financed programs, the outcomes are in this case not substantially different from the user-financed ones: with or without pro-poor targeting, the poor normally gain access to these programs, and become better off from their participation. For instance, in the CRP, poor farmers are not being targeted, but are strongly over-represented in the contracts, since the program caters to marginal lands at the edge of profitability. In the Mexican PSAH, the sheer focus on natural forest areas automatically makes some of the remotest and most poverty-struck areas eligible for application.

As long as participation of service providers is voluntary, we assume they will look after their own interests by only accepting payments that at least match their opportunity plus other costs. While we thus expect the impact of PES on participants to be positive, we don't know how significant the benefits are. The data on the extent to which participants benefit is weak, but it seems likely that none of our case-study programs results in generalized substantial welfare improvements; rather, PES probably delivers small gains over and above opportunity costs. However, even nominally small gains can become relatively important when few alternative cash sources exist. Non-income effects can sometimes also be important. In Costa Rica and at Los Negros, PES contracts were found to help increase tenur security. In a situation of weakly defined property rights in Kalimantan (Indonesia), PES was found to be likely to induce more secure property rights by raising the value of natural resources to local people. Finally, in particular in the case of water services to large cities, one should not overlook the health improvements that multiple poor service users can obtain from cleaner or more regularly supplied drinking water (Wunder, 2008b).

[40] This assumes that there are poor people in the ES supply areas. Pagiola et al. (2007b) show that, contrary to conventional wisdom, areas that are important for water services are not necessarily high poverty areas. In fact, they find no correlation between the importance of an area for water supply and either poverty incidence or poverty density.

Several trade-offs are worth pointing out. First, explicitly targeting the poor may come at the detriment of achieving environmental objectives. When the criteria for spatial targeting or for enrolling applicants is something other than capacity to deliver ES, the program's effectiveness is likely to decline. For instance, the CRP in the US has experienced politically-determined shifts favoring farmer-income support objectives over efficiency in the performance of ES delivery. Second, efforts to maximize the benefits generated per dollar spent come at the expense of welfare impact. To the extent that PES programs succeed in capturing all the informational rents in service delivery – that is, paying providers just barely over their cost of provision – there will be little or no net benefit to providers. Substantial efforts have been devoted to devising ways to capturing informational rents, but there is no clear general reason to justify allocating all informational rents to service buyers. This tends to be what happens in practice, however, as ES buyers tend to be more resourceful and fewer in numbers, and hence have more negotiating power to appropriate these rents.[41]

5. Conclusions and perspectives

PES has attracted considerable attention in recent years. Its growing popularity has not yet been matched, however, with careful analysis of how it works, and of its strengths and weaknesses. This Special Issue of *Ecological Economics* has attempted to help fill this gap by providing detailed case studies of some of the most important PES programs. As the analysis in this paper has shown, these PES programs often differ substantially one from the other. Some of the differences reflect adaptation of the basic concept to very different ecological, socioeconomic, or institutional conditions; others reflect poor design, due either to mistakes or to the need to accommodate political pressures. Some of these programs are in fact hybrids, with only part of their activities properly described as PES and others reflecting a wide variety of other approaches. While we have attempted to draw some of the principal lessons of these programs, we are aware that in many ways we have only begun to scratch the surface, and hope that the detailed information contained in these case studies will provide a rich basis for others to pursue various themes in greater depth.

In this concluding section we discuss what is conceptually special about PES. Why is PES thought to be a promising idea? There are, broadly, two sets of reasons that make PES attractive, one set focusing on the supply side of the conservation problem, and the other on the demand side (Wunder, 2008b).

PES can be considered an important *supply-side innovation* of directly 'buying conservation'. PES deals squarely with the reality that conservation is far from always 'win–win': in fact, very often activities that are desirable from the point of view of society are quite unattractive to the farmers, loggers, fishers, and others who manage ecosystems directly. PES addresses this divergence between social and private benefits directly. Moreover, PES insists on conservation as a quid pro quo: those

[41] This needs not always be so, as shown in the CAMPFIRE experience. In this converse case, service providers are auctioning off access-rights to the highest-bidding tour operators, thus maximizing their respective share of informational rents, at the expense of service buyers.

who provide valuable ES should be compensated — but only if they do, in fact, provide those ES. This promises to be a much more efficient way of achieving conservation. From this perspective, the critical criteria are those of voluntariness and conditionality — particularly the latter. This vision of PES is particularly relevant whenever the environmental financing side is available but is limited, and greater efficiency in environmental spending is the main concern.

PES can also go beyond the goal of spending available conservation funding more efficiently, however. The second reason that PES is attractive is that it can be considered as a *demand-side innovation*. Conservation has frequently been seen as the responsibility of governments. But governments are not always well placed to determine what ES are important and how important they are. Even where governments are aware of the importance of ES, funding for conservation must battle with many other worthy (and quite a few unworthy but politically important) demands on scarce budgetary resources. And even when funds are made available, the incentive structures of government bureaucracies are not necessarily conducive to their being used as effectively as they might be. By tapping ES users directly, most of these problems are bypassed: ES can provide new funding for conservation, but perhaps as important, that funding comes with two vital ingredients: *information* about which ES are valuable, and strong *incentives* to make sure that this funding is spent efficiently (Pagiola and Platais, 2007).

User-financed PES programs are thus much more likely to be efficient than government-financed ones. Even though our sample of case studies was too small to be able to confirm this hypothesis, our results are very much consistent with it. The user-financed programs in our sample were better targeted, more closely tailored to local conditions and needs, had better monitoring and a greater willingness to enforce conditionality, and had far fewer confounding side objectives than government-financed programs. Time and again, the design and operation of government-financed programs was found to be hijacked for many alternative purposes.

When the supply-side benefits are combined with the demand-side benefits, a particularly valuable tool is created. Of course, arranging for users to finance PES is not always possible. There are many instances in which financing by a government body (or some other representative of society) is the only approach that is feasible. This is particularly true for biodiversity services (where free-riding incentives abound), as well as for some water services (depending on the number and structure of the users). It is also true for carbon, except that international agreements such as the Kyoto Protocol and some national laws have created a demand for carbon sequestration, as long as it is achieved in the very particular ways those agreements and laws specify. In many important cases, therefore, there is no alternative but to continue to rely on government funding and operation of PES programs. In these cases, PES at least offers an important tool to improve the supply of conservation.[42] Government-financed programs, thanks to their larger size, also often benefit from significant economies of scale, providing an element of cost efficiency that small-scale user-financed PES programs tend to struggle with.

It is interesting to note that some government-financed programs are attempting to evolve in ways that bring them closer to user-financed programs. Both Costa Rica's PSA and Mexico's PSAH are attempting to develop additional financing sources from individual ES users to complement their public financing, and are trying to move away from their current one-size-fits-all approach to payments to a much more differentiated and targeted approach in which the amount of payment and the specific land uses being paid are much more closely targeted to local conditions. At the opposite end of the spectrum, the challenge is to find ways to help create and operate small-scale user-financed programs in ways that preserves their benefits while also enjoying some of the economies of scale that larger programs receive.

[42] There are cases in which user financing is not connected with direct payments to ES providers. The most notable among these is the case of Quito's Water Fund (FONAG) (Echavarría, 2002). FONAG has developed a significant funding stream from the city's water utility (with additional funding from the electricity company and others), but so far not used this funding for direct payments, except for some funding to protected areas.

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