Review of Payment for Ecosystem Services experiences for REDD+

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Introduction

"Natural ecosystems provide a wide range of ecosystem services from which people benefit, and upon which all life depends. These include provision of food, fuel, building materials, freshwater, climate regulation, flood control, nutrient and waste management, maintenance of biodiversity, and cultural services, to name a few" (Bond et al 2009)

"While the benefits of environmental services are public goods, the cost of ensuring their provision often falls on local land managers. As land is usually managed for private benefit, it is more profitable to cut down forests than to look after them. However, the emissions from deforestation and degradation of forests make up close to 20 per cent of the global emissions of greenhouse gases. Reducing these emissions represents one of the fastest, most significant and cost-effective option for slowing down climate change in the near term" (Bond, 2009). The activities to reduce emissions from deforestation and forest degradation (REDD+) are being designed as a performance-based mechanism that will provide financial compensation to developing countries for fully measured, reported and verified emission reductions relative to baseline levels (Wertz-Kanounnikoff and Angelsen 2009; Karsenty et al. 2014).

Payments for environmental services (PES) create incentives for forest owners for adopting good practices for those land uses that provide ecosystem services; but this is conditioned to compliance with certain rules of specific programs, and not to carbon performance. PES mechanisms compensates for the extra cost of giving a sustainable management to land in comparison with the alternative practices such as livestock or agriculture. Initially PES was defined as a voluntary transaction between at least one service buyer and one service producer, to maintain the provision of a specific environmental service, subjected to its condition provision (Wunder, 2005). In addition to protecting the environmental services, the program aims to avoid trade-off between local and global benefits, poverty alleviation and environmental protection, and between the welfare of present and next generations (Muñoz Piña, 2007).

"Experiences with PES schemes reveal a need to identify the scale and spatial distribution of providers (sellers) and beneficiaries (buyers) of ecosystem services when planning management interventions (Naidoo and Ricketts 2006; Costanza 2008; Fisher et al. 2009). Such interventions include benefit distribution and cost compensation, as well as the design of governing institutions" (Loft, 2014, CIFOR).

Background: The Protection of Ecosystem Services before the beginning of PES *program*

Before the concept of payment for environmental services emerged, in México, the strategy to reduce deforestation and land use change had consisted on direct regulations of activities that degrade natural areas; subsidies for sustainable forestry activities; and the most important (and inefficient), the need to obtain authorization to change land use in natural areas, which requires an Environmental Impact Assessment (EIA). EIAs are limited to big development projects (tourist development, infrastructure, industrial, agribusiness, dams, etc.), so only a small part of the total land use changes have actually been under regulation. For this reason is the government lacked the capacity to handle the numerous small-scale land-use changes. Therefore, the PES program was designed to complement existing policies (Muñoz Piña, 2007). In addition, EIAs are often perceived

as a bureaucratic paperwork with lack of a deep and integral analysis of the entire ecosystem dynamism, i.e, often they are focused only on the conservation of certain animal or vegetal species, and do not include the affectation to other environmental services nor future socio-environmental side impacts. Moreover, there should be included a cumulative impact evaluation. With time EIAs have become in many cases only a bureaucratic processes to be done and not necessarily an objective evaluation of the effects on the environment.

Alix García et al, 2005, proposes to turn the attention to two less expensive interim policies that could be effective initial steps in addressing deforestation: The first one implies addressing existing inefficiencies within the agencies responsible for forest regulation and within other agencies whose policies may indirectly encourage forest misuse. The second option to reducing deforestation without a federally funded PES program is to look for self-sustaining markets for environmental services at the local level. Payments for well-defined local services are easier to administer than a nationwide program and less exposed to discontinuities in the federal policy process.

Review of international PES programs

In the last years, PES systems have been implemented in many parts of the world, such as: Costa Rica, Ecuador, Bolivia, Guatemala, Brazil, China, South Africa, Mexico, and many others. Annex 1 presents a brief summary of the PES experience in different countries.

Of the selected experiences of PES, the Bolivian, Ecuadorian and Zimbabwe cases are user-financed schemes; the Brazilian, Costa Rican and Madagascar cases present government-financed schemes. In all the cases, intermediaries between buyers and sellers of environmental services played an important role and were the main drivers of the schemes; for user-financed experiences, non-governmental organizations played the role of intermediaries; for government-financed, the role was taken by government agencies.

The method used for monitoring depended on the size of the area monitored. For large areas, remote sensing tools were necessary, combined with selective ground-checkup. In a small scheme like Pimampiro, the investment in remote sensing had no sense. In order to assure genuine conditionality, it was necessary not only to monitor non-compliance, but to sanction it appropriately. Sanctions may differ according to the frequency or severity of the detected infraction, or according to whether or not the infraction was intentional (Wertz-Kanounnikoff et al, 2008).

Payments were typically made in cash, but sometimes combined with technical assistance or in-kind compensation. The decision on the mode of payment depends on the local circumstances and needs. “In the case of Brazil where service providers are smallholders and often poor, cash payments were complemented with capacity-building and technical assistance” (Wertz-Kanounnikoff et al, 2008).

The timing of payments in all cases were after verification and only in cases that the contract compliance; with the exception of NK-CAP in Bolivia, where the number of economic activities were completely bought out, thus making it necessary to compensate up front for a series of productive investments (Wertz-Kanounnikoff et al, 2008).

The factors that affect the effectiveness of PES schemes include: baselines, payment design, additionality, leakage control, and permanence. Although baselines are important references to

measure results against, in most of PES schemes they are not studied in great detail and very often results are based on the implicit assumption of a continuation of current trends (Wunder et al. 2008). Leakage is difficult to measure in practice, especially for avoided deforestation (Wunder et al. 2008); the NK-CAP is one scheme that has invested heavily in leakage prevention measures (Brown et al. 2000). Part of the motivation is probably related to testing methods for measureable, additional emission reductions to be sold in international carbon markets (voluntary markets). (Wertz-Kanounnikoff et al, 2008). Permanence is another key factor in ensuring effectiveness. It depended on the strength of public law, and the uncertain changes in the economic environment and in private land-use incentives.

Initial experience with PES schemes had occasionally revealed the risk of not reaching out sufficiently to the poorest land users. Because of certain requirements for participating in PES schemes (e.g., land titles, up front investments to finance licensing of land-use plans or necessary managerial skills), poorer land users can be disadvantaged. PES can also have indirect effects on the poor. In the Bolivian case of NK-CAP, for example, the logging ban made many local people lose the jobs they had with logging companies (Asquith et al. 2002).

Common limitations and challenges for PES

Experience has shown that the four main limitations for successful implemenation are: i) not-clear definition of property rights; ii) forest conservation and slippage; iii) Institutional failures; and iv) lack of a measuring system of the value of Environmental Services. All of them will be explained later. In countries where PES program has been implemented, there has been a common pattern of four obstacles and challenges:

Institutional failures. Frequently government failures are the causes of deforestation and forest degradation. Often, government policies promote the conversion of forests into agricultural areas, livestock and other land uses that degrade the environment and do not provide great economic growth neither reduce poverty. Further, the government does not regulate effectively the forest industry; grants concessions to elite groups and formulates lax, ambiguous and weak enforcement laws and regulations (Kanninen et al 2007; Larson and Ribot 2007). According to the above, a demanding task for the program is to establish a real commitment from the government to look towards the forest conservation, improving the quality and efficiency of laws and regulations; build a coordination system with non-governmental actors; and commit, if is the case, to provide a long-term funding to the program.

Property rights. Traditional forest users lack secure property rights. Without secure tenure, these users lack the basis for sustainable management (Kanninen *et al.* 2007). When communities hold common or customary rights to forests, local institutions often don´t have capacity to specify clear rights and responsibilities for managing forests as well as an ability to mediate disputes (Ostrom, cited in Kanninen *et al.* 2007). Some indigenous people lack legal recognition as citizens; therefore they face additional barriers in obtaining rights to their land (White *et al.* 2008).

Slippage. If payments would only be made for those portions of forests enrolled in the program it would be possible for owners to reduce deforestation there, but increase it elsewhere. Alix-García, 2010, debates between two types of slippage: substitution effects and price increases in output markets. In the context of forest-conservation payments, a substitution effect occurs when a landowner who removes one parcel of land from production (enrolling it in the program) shifts the planned production to another parcel within his landholdings. An output price effect occurs if the removal of multiple parcels of land from production or the introduction of payments alters market

prices and these changes induce changes in production (potentially across all landholdings in the market). Substitution should only occur where there are significant credits, land or labor market rigidities, as suggested by Roberts and Bucholtz (2005). Individual households operating under no constraints will reduce their land in agriculture – thereby increasing their forest area – if the relative prices are high enough to induce enrollment in the PES program. Households which are unconstrained borrowers will also reduce their land in agriculture, increasing forest cover, unless it is the case that the payments from the program allow them to cease borrowing altogether. But constrained households are likely to increase their agricultural production, thereby reducing forest area, relative to their behavior without the program. At a household level, therefore, we expect to observe slippage through substitution where households require borrowing in order to purchase agricultural inputs and are credit-constrained. (Alix-García et al, 2010)

Measuring and communicating the value of ecosystem services. Ecosystems are very complex and measure the benefits that they provide to society is a great challenge. Often when there is no a direct link between providers and beneficiaries of ES (potential buyers), it is more difficult that beneficiaries want to get enrolled in the PES program voluntarily. In addition, it is also easier for beneficiaries to realize the value of services such as watershed or air quality, that biodiversity or carbon sequestration, for example.

Potential/Lessons of PES for REDD+

"Reducing Emissions from Deforestation and forest Degradation (REDD+) is a designed performance-based program that provides financial compensation to developing countries for fully measured, reported and verified emission reductions relative to baseline levels" (Wertz Kanounnikoff and Angelsen 2009; Karsenty et al. 2014). In addition to forest conservation and storing carbon, REDD+ has other co-benefits; e.g. financial flows that generate socio-economic benefits, reducing poverty, and supporting livelihoods; and also the promotion of political changes that result in a better governance and more respect to vulnerable groups (Angelsen, 2010)

Latin America has been a pioneer in testing and implementing PES schemes in developing countries, and these experiences are of high value to REDD+ policy design. Some of the main lessons learned from PES that are actually useful for REDD are:

- It is important to create a multidisciplinary group of both national and international experts to aide in the policy design process. The combination of expertise from outside the country and experts aware of the realities of implementing programs expedited the design of the program and allowed recommendations to be made quickly and effectively.

-Definition of targeting and eligibility criteria. It is important to define which forests would be included, it is necessary to analyze whether or not different types of forests should be prioritized (i.e. based on their role in capturing water from fog in the dry season; in reducing flood damage, water supply, etc.)

- Funding must be guaranteed over a substantial period of time. It is convenient to diversify financial sources: users-financing; international funds, government (trough already existent taxes and public budget), NGOs, etcetera.

- The benefits distributed should compensate for the transaction, opportunity and implementation costs incurred by stakeholders for providing ecosystem services. Using an auction process may help

to induce potential participants to reveal the minimum payment which they would accept in exchange for conservation of the forest.

- In cases where providers and beneficiaries of an ecosystem service are at the same spatial level, institutions at that level can collect and distribute payments, but if the beneficiaries are global it is necessary to connect global beneficiaries with the local providers through intermediaries, to ensure the transfer of monetary benefits. The effectiveness of the program greatly depends on the quality of intermediaries' participatory work and their neutrality.

- Payments should be given at the end of each period, after verification of compliance and that the forest cover had been conserved. Use satellite images which are transparent and difficult to manipulate by interested parties. The program must have clear negative consequences for non-compliance.

- In order to avoid slippage, or the movement of productive activities from the hectares enrolled in the program to other previously unused, it is very important that contracts for payments specified that there should be no change in the entire forested area. This does not imply that payments must be given for all of the hectares of forest (but it would be interesting to consider paying for all the area), but rather that the contracts should eliminate the possibility that deforestation be reallocated from one spot in the community to another.

- The most efficient way of allocating payments in environmental programs is to pay the lowest cost possible for those hectares of land containing benefits that aren´t at risk of being lost (e.g. Natural protected areas, not useful land for agricultural or logging work-out)

- Establish criteria for evaluating the program performance, it will be necessary to establish a baseline that let us know how high emissions would have been in the future in the absence of a PES policy. It is also important to establish a crediting line, or reference scenario to help to determine the "quantity of the emission reductions" that would be remunerated.

- It is essential to increase transparency through information exchange among actors; and define the right to benefit from the ecosystem service and clarify responsibility for service provision. In addition, countries should provide reliable information about changes in forest cover and the amount of carbon sequestered to ask for access to international funds and earn a good reputation in people who potentially could join the program.

- Instead of designing a PES scheme for a specific ecosystem service paid for by the beneficiaries at the same scale at which that service is provided, a promising alternative to increase the total benefits is to batch payments from several ecosystem service beneficiaries for the simultaneous provision of several ecosystem services across multiple scales (OECD 2010). Bundling can reduce transaction costs because a single institution could administer the program and manage the monitoring, reporting and verification of all the ecosystem services.

- It is essential to clarify property rights over the ecosystem service itself or the land providing the ecosystem service.

- An important element is monitoring the provision of the ecosystem service and the conditional disbursement of revenues (Engel et al. 2008; OECD 2010). It is necessary to attend the lack of available and reliable data on land tenure, forest quality and quantity, high cost monitoring technology, low human capacity, and poor information exchange and coordination among sectors and government agencies (To et al. 2012; Alston et al. 2013; Pham et al. 2013b).

- It is important to evaluate three variables: effectiveness, efficiency and equity. The "effectiveness" refers to the amount of reduced emissions; "efficiency" relates to achieve such emission reductions the lowest possible cost; and "equity" refers to the fair distribution of costs and benefits.

- The most important lesson that might be learned is the need to be flexible and to adapt to changing circumstances.

Aspects for comparison REDD+ and PES.

Variable	PES	REDD+
What is being valued	Ensure the provision of environmental services by preserving forest cover.	Reducing emissions from deforestation and degradation, and increase and conservation of forest carbon stocks.
Who pays	Governments can pay through collection of taxes or charges for an ES obtained; Private sector; International Organizations; NGOs; or stakeholders.	It is not clear yet. It is expected REDD+ countries will get performance based finance from international sources presumably developed Annex I countries, but this has not been defined.
How financing is collected/demand is stimulated	The payment can be collected directly or indirectly.	Markets and funds, but operational rules have not been defined. Early experiences include voluntary carbon markets and multi-bilateral programs and initiatives funded by the World Bank and other (FCPF).
Who receives the money	The service provider receives payment for practice a land use that have a positive impact on the ecosystem service (landowners, communities)	The national government; then ad hoc rules are defined within each country to channel the resources among regions and governmental levels, and distribute the benefits between different stakeholders on the ground.
Who produces the ES	Forests and landowners managing them.	The country, as the sum of the effort of different stakeholders, prominently land and forest holders/owners.
How performance is measured	If the operation rules of the program are followed.	Results compared against a baseline; national baseline can be a nested baseline of sub-national ones. In addition,
How additionality is assessed	Through the verification of service providers compliance and ecosystem conservation. Also through the proven increase/maintenance of forest cover.	Against a baseline.
How leakage is addressed	Monitoring with satellite images and making the land-owners to declare all their property land so do not displace their agriculture or livestock activities elsewhere. There are risks for regional leakage.	A national approach ensures the consideration of potential leakage within national boundaries. It is necessary to consider international leakage.
Scale of implementation	PES are implemented at a local or regional scale in scattered areas	National with at step-wise sub-national phase.
Role of intermediaries	Their roles are as service and information providers, mediators, arbitrators, representatives, watchdogs, developers of standards and bridge builders (Pham et al, 2010)	It is not clear how it will be operated, in any case national government may act as intermediaries between international financing mechanisms and stakeholders on the ground. Financial intermediaries may be also needed to facilitate relations between global-scale buyers and local-scale providers of carbon sequestration and storage depending on the schemes selected by each country. These intermediaries can help to collect and

Variable	PES	REDD+
		distribute payments and to promote the scheme to potential beneficiaries.
Role of government	Establish appropriate legislation; facilitator of the mechanism; act as intermediary.	The role of the government is being a promoter and regulator to ensure respect for property rights and to foresee the institutional needs associated with REDD+ given the ongoing process in which the framework is being built at both national and international levels.
Costs generated	Transaction, opportunity and implementation costs.	Transaction costs, costs associated with the creation of institutional agreements, negotiation of contracts, coordination of collective action, monitoring and enforcement of agreed plans, etc.
Temporal distribution of compensation	Paying a fixed annual fee per hectare preserved.	Payment will be ex-post based on performance (in 5 year periods)
Eligible activities	The program targets non-commercial forests in areas with high risks of deforestation or degradation; overexploited aquifers, risk of natural hazards.	A broad number of actions reducing emissions from deforestation and forest degradation and enhancing carbon stocks, promoting the sustainable management of forests and conserving forest carbon stocks. Activities developed within the forests; Activities developed outside forests; General Policies (i.e. sectorial and macro-economic policies and planning laws which have a broad impact on deforestation rates).
Eligible actors	Landowners with a defined land property and tenure.	Individuals, groups or organizations holding rights over forest land.
Potential for reaching the poor	Even when poverty alleviation is not a main objective of the program; it is one of the eligibility factors. If an area is equally valuable for the environmental services it offers and is equally at risk of deforestation, then it is better that the poorest communities are those who receive the payment.	REDD+ include in their targeting strategy, to look toward the poor. The links between environmental protection and poverty reduction play an important role, because smallholders, which could be defines as comprising indigenous groups, traditional communities, and small-scale settlers, own a big part of the forests. The introduction of market mechanisms for environmental services has the potential to benefit rural service providers, in economic terms, if the payment received more than compensates the opportunity cost of giving up a more rewarding land use.
Type of payment/compensation	In cash or in kind. Studies have shown that both options are accepted by the beneficiaries.	In a global scale, payments are in cash; in a national scale it depends on the landowner's needs and circumstances.
Permanence of activities	To avoid that ES provision stops as soon as payments from ES buyers to sellers are terminated; an adequate contract length has to be made. In addition is necessary to be more profitable conserving the forest than investing in any other productive activity (e.g. limiting agrochemical use could eventually become profitable for farmers because of decreasing expenses on pesticide).	Financial support is needed to address permanence issues form of insurance against disturbances (e.g. hurricanes, fires, pests) (Balderas et al, 2014)
When it can be effective to reduce emissions from deforestation		Emissions from degradation should be reduced through a sustainable management of timber; avoiding illegal logging and reforestation actions.
When it can be effective to reduce emissions from degradation		Emissions from degradation should be reduced through sustainable use of resources, natural regeneration, controlled use of fire and incentives for such sustainable practices.
When it can		

Variable	PES	REDD+
promote sustainable management of forests		
When it can promote enhancement of carbon stocks		
When it can promote conservation of carbon stocks		
What other benefits are generated by the programs?	In addition to improving environmental performance, PES programs also provide benefits for business and stimulating the development of creative solutions, so minimizing any unnecessary burdens on the wider economy.	REDD-plus is foremost a climate change mitigation strategy. However, it can provide significant adaptation benefits for societies and its long-term success will depend on the ability of forest ecosystems to adapt to climate change.

General information on PES Characteristics

Working with communities. "In México, 80% of forests are *ejido* properties, i.e., owned by common holders. Legally, *ejido* governance is organized by four main actors: the assembly, the authority, the surveillance council, and the *ejido´s* judge (arbitrates conflicts among community members, and religious authorities). Rules of use and access to the forest commons are contingent on the *ejido's* internal regulations, but actual policies already allows the division of the land into smallholdings, which could then be privatized. The forest commons could now be sold to a third party but the activities developed by the buying party had to be economically and socially equitable, as well as environmentally sound". (Kosoy et al, 2008)**.** The management of the payments for PES programs is administrated by the communities. Some of them use all the income to invest in public goods; others divide equally the payment among members, and others have a mixed strategy. A problem identified in most of PES experience is that few *ejido* members aside from those with directive or representation functions knew the conditions of the contract (Muñoz-Piña, 2007). Therefore, it would be convenient to add to the PES program a meeting with the entire landholders of each *ejido* to talk about the terms of the contract.

PES and eligibility. On PES programs, an essential aspect to consider in its design is the eligibility criteria, i.e. define which forests would be included, what actions would be rewarded, and how much would be paid. In addition to offering valuable ecosystem services, some of the main eligibility rules are that applicants must have proof of property rights, a long-term commitment to PES through a community forest management plan; they cannot be receiving support from any other PES programs. Also, the socio-economic situation contributes to the eligible process, i.e. areas with an equal value for the environmental services it provides and is equally at risk of being lost, then it is better that the poorest communities get enrolled in the program. Another main issue to analyze is whether different types of forests should be prioritized. A Blue Ribbon Committee of Mexican and international scientists concluded that cloud forests were most important because of their role in capturing water from fog in the dry season (Bonell and Bruijnzeel, 2005). Some argued that dry tropical forests were also important for their role in reducing flood damage. The debate ended that the program would begin considering two priority levels of forests: the cloud forest and all the other types of forest. (Muñoz Piña, 2007). For Hydrological PES programs, eligible area

requires to be located in the recharge area of overexploited aquifers, in watersheds with high water scarcity, or in areas with high flood risk. (Muñoz Piña, 2007).

PES and conditionality. A PES program must have clear negative consequences for noncompliance. In the case of purposeful land use change, demonstrated by actually observing pasture or agricultural fields in previously forested areas, participants should not receive any payment at the end of the year, no matter how small the change. If deforestation occurs for other reasons, e.g. because of accidental forest fires or timber theft, participants should not get paid for the lost area, but do get paid for the remaining forest area (Muñoz-Piña, 2007). In addition to satellite images, and ground measure, a good choice for monitoring and compliance verification is to estimate the Normalized Difference Vegetation Index (NDVI), which is the best available indicator of changes in forest cover; however it may have some errors in the indicator of forest loss because of weather shocks or because changes may reflect degradation rather than deforestation (i.e. very small areas of deforestation would be missed). An option to correcting this potential censoring problem is to use Tobit regression in the data analysis (Alix-García et al, 2010).

PES payments. A critical issue on the design of a PES program is who the 'buyers' of the ES are. In particular, there is an important distinction between cases in which the buyers are the actual users of the ES, and cases in which the buyers are others (the government, an NGO, or an international agency) acting on behalf of the users of the ES. Under the system of government-financed, the government acts as the service buyer. These programs typically feature multiple services and side-objectives, and are not immune from changes in public policy and the allocation of government funding. Their large scale allows them to exploit certain administrative economies of scale, and thus achieve cost efficiencies (Wunder et al. 2008). On the other hand, on user-financed systems, water and energy companies, municipalities or other, pay for the ecosystem service directly. These programs are smaller, typically single service focused, and more spatially targeted. They thus tend to be more efficient than government-run schemes. However, they are more expensive to set up, so often may be less cost-efficient per hectare covered (Wunder et al. 2008). "The payment offered to ecosystem managers must exceed the additional benefit they would receive from the alternative land use (or they would not change their behavior) and must be less than the value of the benefit to ES users (or users would not be willing to pay for it). Many PES programs use fixed payments per hectare for given activities; alternatively, payments may be differentiated in space and/or across agents on the basis of ES provided (benefit targeting), costs of ES provision (cost targeting) or a mixture of both" (Engel et al, 2008)

PES and Poverty. "The introduction of market mechanisms for environmental services has the potential to benefit rural service providers, in economic terms, if the payment received compensates the opportunity cost of giving up a more rewarding land use. The benefits can be such as diversification of income sources, reliable and stable payments, provision of training, and better internal organization among service producers. However, these transactions can also impose costs, e.g., increased competition for land or social tension because of jealousies from community members that do not receive payments […] Also landless people, often among the poorest of the poor, are excluded. Even landholders with plots sized just a couple of hectares would often find it impossible to set aside land areas predominantly for environmental service production. Finally, landholders with an insecure tenure and lacking access control are unreliable service providers. Since PES schemes appeal to land-owning and land-controlling participants, it is more complicated to assist the poorest people" (Grieg Gran et al, 2005). The worldwide debate about the effects of PES on poverty is beginning to be controversial. While it is crucial to promote a PES scheme that considers the effects of payments on poverty reduction, these should not affect the main purpose of the program: conservation and provision of ES. If the objectives of the program are not clearly defined, PES will begin to deviate to a matter of gender, indigenous people, human rights and

poverty alleviation. Anyway, poverty reduction could be a valuable aspect for eligibility criteria, i.e. if an area is equally valuable for the environmental services it provides and is equally at risk of being lost, then it is better that the poorest communities get enrolled in the program.

General information on PES in Mexico

The case of Mexico's federal Payments for Hydrological Services program (PESH)

The article of Sims et al, 2014 used the case of Mexico's federal Payments for Hydrological Services program to study the importance of adaptive management for achieving the goal of enrolling lands of high environmental and social priority. They define *Adaptive Management* as a composition of three parts: "management by experiment" (i.e. experimental program design); systematic acquisition and application of reliable information" (i.e. Monitoring and evaluation of impacts); and continuous redesign of policy in response to evidence and feedback from stakeholders.

The PESH program began in 2003 with the main goal of conserving forests to improve water quality and quantity for downstream communities and secondary social goals of maintaining rural incomes and reducing poverty. In the first years of the program, the Mexican National Forestry Commission (CONAFOR) compensates landowners with a payment of US$27.3/ha for conserving all forest types except cloud forests, which would be paid US$36.4/ha due to their higher value in terms of hydrological services. Payment rates were originally based on approximate calculations of the average opportunity cost of land conversion from forest to maize crops. Payments would be made annually, after verifying that no land use change had occurred and would be renewed for 5 years if conditions were fulfilled. In addition to those payments; the program encourages sustainable forest management by requiring and providing funds to hire technical advisors to deliver training and create forest management plans. (SIMS et al, 2014)

As for eligibility criteria, the sites targeted were those with a potential demand for hydrological services, i.e., in overexploited watersheds and upstream from population centers greater than 5,000 (Shapiro 2010). "The targeting system was criticized for not enrolling enough areas at high risk of deforestation and not reaching enough economically and socially marginalized communities. In response, PESH program managers expanded eligible zones, allowed applications from smaller stakeholders, and change the selection system. To increase the accuracy and transparency of the selection process, they created a system in which they assigned "points" to applicants based on multiple criteria, including risk deforestation, surface water scarcity and location in a major indigenous poverty municipality" (Sims et al, 2014).

Another important goal of the program was to induce independent markets for hydrological services, looking forward for payments to be more sustainable in the long run if they came directly from local, downstream hydrological services users (Pagiola et al. 2002; Munoz-Piña et al. 2008). However, after the initial 5-year contract period, few independent markets had formed. In response to pressure to continue contracts, CONAFOR allowed renewal and implemented a series of rules to encourage clustering of applicants within watersheds.

In 2010 CONAFOR stopped expanding the eligible zones and began to downsize and re-prioritize them. In addition, the system transitioned from flat-rate payments to flexible dynamic payments based on local context, including forest types and the opportunity cost of foregone land conversion. To evaluate enrollment outcomes overall 2004 to 2010, Sims et al, 2014, compared characteristics of a random sample of areas from within the boundaries of enrolled land to a random sample of areas from within the boundaries of all land submitted for application to the program and a random sample of areas from within all forested land in Mexico. To evaluate how changes in program management led to changes in selection of areas over time, they analyzed environmental and social characteristics for areas eligible for the program for all enrolled parcels and for parcels that were submitted for application for each program cohort from 2004 to 2010.

The authors found that higher deforestation risk areas were selected from the pool of possible applicant areas, but the pool had on average a lower risk of deforestation than all forested areas in Mexico. The differences in deforestation risk between enrolled areas and applicant-pool areas were generally negative in the early years of the program but positive after 2006, indicating increasing efforts to select higher risk properties from the applicant pool over time. The difference in poverty indexes between accepted and applicant-pool land also increased in the later years of the program. The results of the analysis demonstrate that PESH increasingly enrolled areas of high ecological and social priority over time in response to policy adjustments driven by adaptive feedback loops. The article found 3 factors that facilitate the adaptive management in Mexico: political environment that encouraged experimentation and critical thinking; the availability of relatively high quality data and technical capacity; stakeholder participation in the design and implementation process is important for meaningful adaptive management.

Alix García et al (2010) also have analyzed the impact of Mexico's payments for hydrological services program using recipients enrolled in an early cohort of the program. They found that the program has reduced the probability of deforestation by approximately 6-10 percentage points and has reduced the area deforested among deforesters by 2-11 percent. In particular, the program seems to be more effective in generating avoided deforestation where road infrastructure is good and it seems to be most effective in the northeast and central states of Mexico.

A case study in communities receiving the pilot payments in the states of Michoacan, Puebla, Veracruz, Durango, Chihuahua, and Coahuila (Alix et al, 2005)[1]

In the winter of 2004-2005, "eleven communities were chosen and teams of two investigators were sent to each, where they conducted group interviews with available ejido members, as well as individual interviews with different parties of interest. The studies cover a variety of communities with varying membership and size in different institutional situations. The membership size varies from 40 to 225, while the area variation is from 493 to over 10,000 hectares. The forest area enrolled in the PES program in each community also varies widely, ranging from 73 to 1,400 hectares" (Alix-García et al, 2005). "The results of the experiment showed that in all cases, communities were practicing some kind of forest conservation measures before receiving payments from the program. In some cases, payments induced an increase in conservation activities and greater participation of community members in these activities. In two instances, payments resulted in a shifting of extractive activities from PES land to other land within the *ejido*. In two other cases, the receipt of payments changed the bargaining power of particular groups within the communities – *ejido* members with forest on their parcels threatened to cut it down if they were not given larger

[1] studies were conducted by Adán Martínez Cruz, Josefina Braña Varela, and Jaime Sainz Santamaría

shares of the payments in the coming year. Overall, the effect of the payments on the internal dynamics of the communities has not been very large, perhaps because in many cases the magnitude of the payments is quite small" (Alix-García et al, 2005). An additional reason for the apparent small impact of the program may be that its goals and mechanisms were not well understood by recipients, and technical assistance that might facilitate this understanding had been entirely absent.

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Annex I PES International Experience

Costa Rica

Costa Rica developed an elaborate a PES program in 1997, when Forest Law No.7575 recognized the importance of forest in providing hydrological services, mitigation of greenhouse gas emissions; biodiversity conservation; and the provision of scenic beauty for recreation and ecotourism. The law began giving the regulatory basis to contract landowners for the services supplied by their lands, and established the National Fund for Forest Financing (Fondo Nacional de Financiamento Forestal, FONAFIFO) (Pagiola, 2007). FONAFIFO is a semi-autonomous agency with independent legal status which is composed by three representatives of the public sector and two from the private forest sector.

At the beginning of the program, the source of financing was the government budget. But later, it changed to an earmarked tax and payments from the beneficiaries. From 2001 to 2006, the PES program was supported by a loan from the World Bank and a grant from the Global Environment Facility (GEF). Another project, Mainstreaming Market Based Instruments for Environmental Management (MMBIEM), has continued supporting the program since 2007. The PES Program has also received a grant from German aid agency KfW through the Huetar Norte Forest Program. What really concerned Costa Rican program was that these agreements are not intended to be renewable. Efforts to generate financing from the local tourism industry to conserve the indirect benefits of natural ecosystems have not borne fruit (i.e. several hotels are paying for watershed conservation, but they are doing so to protect their water supplies, not to preserve biodiversity). In response to the lack of long-term funding, Costa Rica had earmarked for each specific environmental service, his own financing source. For example, for water service, the country expanded the use of water payments by revising its water tariff and introduced a conservation fee for watershed which 25% is channeled through the PES program. In the case of carbon sequestration, the financing source has been obtained by allocating to FONAFIFO 3.5% of the revenues from a fossil fuel sales tax. In addition, Costa Rica has also sought to sell carbon emission reduction credits and specified for PES contracts that the rights to any resulting emissions reductions belong to FONAFIFO. It is noteworthy that most of Costa Rica's emission reductions are generated by avoided deforestation rather than reforestation. However, the real challenge is to find the financing source for landscape and biodiversity, some negotiations were undertaken with several ‘users’ but they did not result in any agreements (Pagiola, 2007).

As for who can get enrolled in the program and be paid, landowners must present a sustainable forest management plan prepared by a licensed forester. These plans must describe the proposed land use, and include information on land tenure and physical access; topography, soils, climate, drainage, actual land use, and carrying capacity with respect to land use; plans for preventing forest fires, illegal hunting, and illegal harvesting; and monitoring schedules. The initial payment can be requested at contract signing, but subsequent annual payments are made after verification of compliance. The contracts are renewable by mutual agreement every five years (Pagiola, 2007).

At the end of 2005, about 270,000 ha were enrolled in the program. The forest area enrolled in the PES program at the end of 2005 represented about 10% of the country's forest area. This high percentage, coupled with the country's success at reversing deforestation trends, makes it tempting to attribute the one to the other. Also, Tattenbach et al. (2006), using data on water use from Fallas (2006), find that 35% of the area under forest conservation contracts is in watersheds with

downstream surface water users. Using their estimates of avoided deforestation, they find that 644 million m^3/year of water for consumptive uses and 7224 million m^3/year of water for hydropower production are being protected from deterioration in quality. Moreover, only a small part of the hydrologically important areas was being reached. For carbon sequestration, the 21,000 ha of plantation that the PES program contracted between 1998 and 2005 have sequestered a cumulative total of about 1 million tC in that time period (Pagiola, 2007).

Does the PES program have benefited the poor? Although PES programs like Costa Rica's PES are not designed to be poverty reduction programs, the frequently high spatial correlation between areas that supply environmental services and poor areas create opportunities for PES to contribute to this objective (Pagiola et al., 2005). A problem that affected the participation of the poor early in the PES program was lack of titles. More recently, the law was changed to allow participation of landowners that lack titles.

With the experience, many of the weaknesses of the PES program are being gradually corrected. It is evolving towards a much more targeted program, and the use of more differentiated payments, to allow for differences in both the level of service provision and the opportunity cost of providing services. The major weakness in the PES program is its lack of data on the extent to which its activities are, in fact, generating environmental services. The efficiency and long-term sustainability of the program demand that understanding of how different land use practices contribute to generating environmental services be substantially improved (Pagiola, 2007).

Bolivia

The Noel Kempff Mercado Climate Action Project in Bolivia was established in 1997 with the objective of mitigating CO2 emissions from deforestation. This was realized through compensation to forest concessionaires for giving up their logging rights on government owned lands to expand the area of the National Park; the prohibition of deforestation in protected areas within the park by reducing logging and agricultural burning; and initiating alternative income-generation programs for surrounding communities to compensate for lost forest access rights and lost salary employment with timber companies (Wertz-Kanounnikoff et al, 2008). "The NK-CAP has been reported as successful since the start, but it should be remembered that the area has not witnessed strong deforestation pressures. Between 1997 and 2005, 989,622 tons of CO2 emissions were avoided" (Wertz-Kanounnikoff et al, 2008)

Brazil

The Forest Stewardship Program (Bolsa Floresta) in Amazonas State, Brazil has been implemented since 2007 by the Amazonas Sustainable Foundation, the public Secretariat for the Environment and Sustainable Development and Bradesco, the largest private bank in Brazil. The program consists on reward indigenous communities and long-term settlers for their commitment to avoid deforestation. Eligible to participate are families, communities or family associations (Wertz-Kanounnikoff et al, 2008). Families are required to participate in a two-day training course on sustainable land-use management prior to joining the program. Payments differ depending on participant type (families, communities or family associations). A penalty is applied when participants deforest beyond a maximum limit or render their land uses unsustainable (Wertz-Kanounnikoff et al, 2008).

Ecuador

*In Pimampiro (Ecuador), there i*s a watershed PES scheme that has been implemented since 2000 in order to secure water quality and dry-season quantity through forest conservation *in* uplands communities with potential for agricultural activities. The funds for recurrent PES transfers come from 20 % water consumption surcharge, plus the interest generated by a water fund. (Wertz-Kanounnikoff et al, 2008). In the beginning, PES contracts lasted for five years, but since the end of 2005 participants have renewed the contract for an indefinite period. The quarterly payments are conditional on contract compliance and vary depending on the type of forest. The program shows ample success: deforestation has stopped and the native vegetation cover has regenerated markedly. However, a great challenge for the program is to maintain a credible monitoring system under a tight budget. (Wertz-Kanounnikoff et al, 2008).

Madagascar

Sheila Wertz-Kanounnikoff et al (2008) presented a system of targeting and implementing payments for ecosystem services in Mantadia, Madagascar. The main objective of their article was to show a useful method for identifying potential sites that could be beneficial from a biodiversity conservation perspective and that are cost-effective and efficient from an economic perspective to be considered for PES. They used spatial data to map where important areas for biodiversity conservation overlap with carbon and water services.

The Mantadia Project is a 30-year project which represents a voluntary agreement between “sellers” and “buyers” of carbon, and local communities living in the area are willingly participating in the project. The government is the actual “seller” of the carbon emission offsets (i.e. the government owns the rights to forestland and therefore carbon emissions); and the initial “buyer” of the carbon emission reductions is the World Bank's BioCarbon Fund, but carbon funding covers only a portion of the 30-year project activities, thus additional funding is provided by a consortium for biodiversity conservation and sustainable development including the Government of Madagascar, Conservation International, and the U.S. Agency for International Development. (Wertz-Kanounnikoff, 2008)

In the analysis the authors focused on the provision of biodiversity, carbon, and water services in existing forests and wetlands in Madagascar because they are the most cited services in the literature for having potential PES buyers (Landell-Mills and Porras, 2002;Wunder, 2005) and are also the services where spatial data is easily attainable at the national scale. In mapping these three services was measured the magnitude of the service provided and, when applicable, the demand or “value” for the service by beneficiaries. It was necessary to capture differences in the value of services across space (i.e., one valuable ecosystem may have more beneficiaries than another). There are several methods one could use to measure the value of services to humans, such as monetary valuations or qualitative indexes of people's preferences (Wertz-Kanounnikoff, 2008)

A weakness of the method is that is static, and so does not account for the potential temporal changes in ecosystem service provision, demand for services, and opportunity costs of land, or the interactions of these variables across space. Anyway, it works; sixty percent of the areas identified for PES in this analysis overlap with existing or proposed protected areas. With better data in hand, this type of targeting methodology could be replicated nationally or at a regional or local scale. Furthermore, the institutional and legal frameworks on biodiversity conservation still need to be developed (Wertz-Kanounniko, 2008). Finally, from the brief review of the Mantadia Project, important challenges and opportunities for implementing PES projects were identified. These

included the need for capacity building with local organizations and government agencies, alignment of government institutions for better policy coherence, and clarification of land tenure before securing PES opportunities. These experiences suggest that upfront investments in PES "infrastructure" will be necessary to create the enabling conditions to implement PES successfully. (Wertz-Kanounnikoff, 2008).

Zimbabwe

Peter G.H. Frost and Ivan Bond, 2007 article, *"The CAMPFIRE program in Zimbabwe: Payments for wildlife services"*, tell us about a long-standing precursor to PES which could provide lessons for PES about implementation, performance, outcomes and adaptation. The Communal Areas Management Program for Indigenous Resources (CAMPFIRE), started in the late 1980s in Zimbabwe, and subsequently widely emulated elsewhere in southern Africa. It involves the sale by rural authorities of the rights to access wildlife to entrepreneurs who in turn market safaris to hunters and eco-tourists.

The principal service sellers in CAMPFIRE are the farming communities, whose land- and resource-use decisions ultimately determine the fate of wildlife. The Rural District Councils (RDCs), being authorized by government to receive and manage wildlife revenues on behalf of communities, serve as intermediary. The service is bought by safari operators from the communities ties through contracts with the RDCs. Safari operators are essentially wholesalers who buy the rights to bring sport hunters and eco-tourists to their concession areas to hunt a set quota of animals, or track, observe and photograph wildlife. CAMPFIRE therefore most closely fits the PES concept of payments for landscape beauty. (Frost, 2007)

"All of the communities involved in CAMPFIRE are classed as poor" (UNDP/PRF/IDS, 1998). "Given that most households have received only limited income from CAMPFIRE revenues, the direct financial impact on poverty, especially of the poorest, has been marginal. Nevertheless, from a development perspective, the redistribution of power and the formation of effective units of common property management have been important achievements" (Hulme and Murphree, 2001).

CAMPFIRE was never conceived as a payment-for-environmental services program, though it exhibits many PES-like features and has lessons learned that could inform the emerging debate on how best to implement PES. The main lesson is that non-differentiated payments minimize the risk of envy and internal division undermining implementation; but the incentive is diluted, or the intervention causes outright losses for those households carrying disproportionate opportunity costs. The flexibility of CAMPFIRE has been one of its major strengths, as it has allowed considerable variation in functioning to emerge. (Frost, 2007)

Annex II. Summary characteristics of PES case-study programs made by Wunder et al 2008.

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