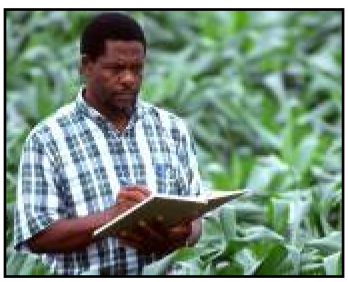

Volume 2, USAID PES SOURCEBOOK

SUPPLEMENTAL READING ON BEST PRACTICES FOR PRO-POOR PAYMENT FOR ECOSYSTEM SERVICES

OCTOBER 2007

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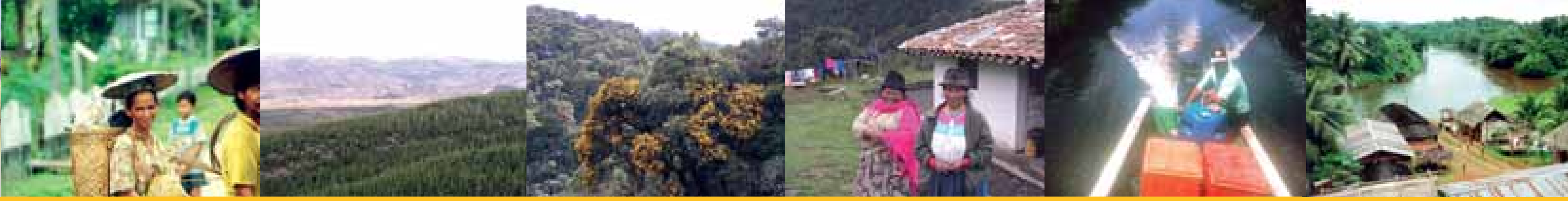

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Payments for environmental services: Some nuts and bolts

Sven Wunder

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Payments for environmental services: Some nuts and bolts

Sven Wunder

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Acronyms and Abbreviations

CDM	Clean Development Mechanism (under the Kyoto Protocol)
CIFOR	Center for International Forestry Research (Indonesia)
ES	Environmental service
ICDP	Integrated conservation and development project
IPCC	United Nations Intergovernmental Panel on Climate Change
NGO	Non-government Organization
NTFP	Non-timber forest product
PES	Payments for environmental services
PROFAFOR	Programa FACE de Forestación para el Ecuador (FACE – Forest-absorbing carbon-dioxide emission forestation program in Ecuador)
RISEMP	Regional Integrated Silvopastoral Ecosystem Management Project (in Colombia, Costa Rica, and Nicaragua)
RUPES	Rewarding the Upland Poor for Environmental Services (a program to promote PES in Asia)
SDC	Swiss Agency for Development and Cooperation
VAT	Value added tax

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Conditionality — the 'business-like principle' only to pay if the service is actually delivered — is the most innovative feature of PES vis-à-vis traditional conservation tools (photos by Brian Belcher, Christian Cossalter and Sven Wunder).

Abstract

Payments for environmental services (PES) are part of a new and more direct conservation paradigm, explicitly recognizing the need to bridge the interests of landowners and outsiders. Eloquent theoretical assessments have praised the absolute advantages of PES over traditional conservation approaches. Some pilot PES exist in the tropics, but many field practitioners and prospective service buyers and sellers remain skeptical about the concept. This paper aims to help demystify PES for non-economists, starting with a simple and coherent definition of the term. It then provides practical 'how-to' hints for PES design. It considers the likely niche for PES in the portfolio of conservation approaches. This assessment is based on a literature review, combined with field observations from research in Latin America and Asia. It concludes that service users will continue to drive PES, but their willingness to pay will only rise if schemes can demonstrate clear additionality vis-à-vis carefully established baselines, if trust-building processes with service providers are sustained, and PES recipients' livelihood dynamics is better understood. PES best suits intermediate and/or projected threat scenarios, often in marginal lands with moderate conservation opportunity costs. People facing credible but medium-sized environmental degradation are more likely to become PES recipients than those living in relative harmony with Nature. The choice between PES cash and in-kind payments is highly context-dependent. Poor PES recipients are likely to gain from participation, though their access might be constrained and non-participating landless poor could lose out. PES is a highly promising conservation approach that can benefit buyers, sellers and improve the resource base, but it is unlikely to completely outstrip other conservation instruments.

Keywords: *Environmental services, rural livelihoods, conservation, economic incentives, stewardship, ICDPs, Bolivia, Brazil, Indonesia.*

1. Introduction

Following the Brundtland Report (Brundtland 1987) and the Rio 1992 conference, tropical conservation gradually headed in a more people-oriented direction. The trend reflected the conventional wisdom that alleviating poverty was the only way to conserve and protect the environment. Integrated conservation and development projects (ICDPs), and sustainable forest management were two major instruments intended to simultaneously increase incomes and conserve the environment (Salafsky and Wollenberg 2000; Pearce, Putz, and Vanclay 2003). Yet despite scattered successes, neither approach has so far achieved major shifts in tropical land-use trends (Brandon, Redford, and Sanderson 1998; Sayer 1995) or silvicultural practices (Poore 2003; Rice 1997). Moreover, there are fundamental doubts about the extent to which it makes sense to forcibly link the conservation and poverty-alleviation agendas when the trade-offs outweigh the synergies (Adams et al. 2004; Wunder 2001).

Based on these insights, much debate has emerged around the need for new conservation paradigms. The concept of payments for environmental services (PES) is at the centre of calls for more direct conservation approaches (Hardner and Rice 2002; Niesten and Rice 2004; Scherr, White, and Khare 2004; Ferraro and Kiss 2002). As wilderness and natural habitats shrink, environmental services (ES) previously provided free by Mother Nature are becoming increasingly threatened. This emerging scarcity makes them potentially subject to trade. The core idea of PES is that external ES beneficiaries make direct, contractual and conditional payments to local landholders and users in return for adopting practices that secure ecosystem conservation and restoration.

This contingent method differs fundamentally from other conservation approaches. Instead of presupposing win-win solutions, this approach explicitly recognizes hard trade-offs in landscapes with mounting land-use pressures, and seeks to reconcile conflicting interests through compensation. Compelling conceptual arguments have been made that PES schemes are more cost-effective than ICDPs (Ferraro and Simpson 2002; Simpson and Sedjo 1996). While PES schemes exist in some developed economies, they remain poorly tested in developing countries. There are many incipient PES initiatives (Landell-Mills and Porras 2002; Pagiola, Bishop, and Landell-Mills 2002), but for implemented PES schemes with money really changing hands in a conditional way, one is typically referred only to Costa Rica and a dozen other pioneer experiences, mostly in Latin America.

Four ES types currently stand out:

1. Carbon sequestration and storage (e.g. a Northern electricity company paying farmers in the tropics for planting and maintaining additional trees);
2. Biodiversity protection (e.g. conservation donors paying local people for setting aside or naturally restoring areas to create a biological corridor);
3. Watershed protection (e.g. downstream water users paying upstream farmers for adopting land uses that limit deforestation, soil erosion, flooding risks, etc.);
4. Landscape beauty (e.g. a tourism operator paying a local community not to hunt in a forest being used for tourists' wildlife viewing).

Sometimes several services can be provided in a synergetic way — and a 'bundled' payment scheme can enable several service users to package their payments to service providers. But not all services are truly threatened and scarce, and not all users are willing to pay. Partial trade-offs between services are also likely: for example, a fast-growing plantation that maximizes carbon sequestration is perhaps not particularly biodiversity-rich, water-enhancing or attractive for tourists. Environmental services other than those listed above could potentially be traded (e.g. wilderness areas providing pollination services to agriculture), but so far only the four identified above exhibit significant commercial scale.

How have conservation and rural development circles received this emerging paradigm? It is fair to say reactions have been mixed. PES advocates stress that innovation is urgently needed because current approaches provide too little value for declining funding; that PES can provide new (especially private-sector) funding; and that poor communities selling these services can improve their livelihoods. Skeptics, however, fear that PES will 'bring back the fences' by decoupling conservation from development; that asymmetric power distribution means powerful conservation consortia may deprive communities of their legitimate land-development aspirations; and that commercial conservation may erode culturally rooted, not-for-profit conservation values (Romero and Andrade 2004; Karsenty and Nasi 2004; Karsenty 2004; Vogel 2002).

In addition, some PES opponents have vested interests. For a donor, money changing hands from a service buyer to a seller obviously provides fewer photo opportunities than a multifaceted rural development project — and is thus a harder sell to a home constituency that wants to believe in the power of point-wise, system-changing interventions for the common good, rather than in the existence of infinite externalities making necessary infinite payments. Integrated development NGOs and consultants risk losing their *raison d'être* with the prospect of PES replacing ICDPs; a whole different skill set would be required, such as land-use and service monitoring, facilitating negotiation, and financial intermediation. For land-use planners, PES implies recognition of recipients' right to freely determine land use, in spite of conflicts with land-use plans that may exist. Not surprisingly, many see PES as a threat rather than an opportunity, regardless of its potential virtues.

At this embryonic stage, mainstreaming PES in the tropics probably faces two key obstacles and a communication barrier. The first obstacle is limited demand: too few service users are so confident about the mechanism that they are willing to pay — in some cases, because the link between land use and ES provision is insufficiently understood or ambiguous (see below). The second obstacle is poor knowledge about the dynamics of ES supply. Where there is ES demand and willingness to pay, what are the institutional preconditions required for suppliers to negotiate a PES deal? If a PES takes off, how will direct, contingent benefit transfers work in often remote, cash-poor communities — both as resource-use incentives and in terms of local livelihood dynamics? Too little is known, and more hands-on experiments are needed. Finally, communicating the PES concept is a problem. Proponents often use an economic rationale, while skeptics draw on other social sciences (anthropology, sociology, psychology, political science). Obviously, there is scope to mediate between the two.

This paper does not address the first obstacle, 'unwillingness to pay', which is dealt with elsewhere (Balmford et al. 2002; Balmford and Whitten 2003; James, Gaston, and Balmford 2001; Wunder et al. 2004; Gutman 2003). Instead, it focuses on the second obstacle: the incentive and livelihood mechanics which so far have received comparatively less attention. Hopefully the paper can also better clarify the PES concept among conservation stakeholders, including its potentials and pitfalls, and lead to a better understanding of which niche PES is likely to occupy in the conservation toolbox. Arguably, PES is the most promising innovation in conservation since Rio 1992, but it needs to be tried out on a much larger scale with more variety in applications to learn what works and what does not.

The PES 'nuts and bolts' in this paper will take the reader to the intermediate level of what questions need to be asked before designing a PES; it will not provide a step-by-step field manual of how to implement a PES scheme. This exercise will mostly use forest-based examples, drawing on detailed field assessments carried out in Bolivia and Vietnam, supplemented by selective experiences from Ecuador, Indonesia, Costa Rica and Brazil.

The following specific questions are addressed. How is a PES scheme defined, and how does it differ from other conservation approaches (Section 2)? How can one evaluate to what extent an ES has been delivered or not (Section 3)? Is PES likely to suit some land-use scenarios better than others (Section 4)? Is there a trade-off between efficiency and fairness (Section 5)? Who exactly should be paid (Section 6)? Should payments be in cash or in kind (Section 7)? Is PES useful for poverty alleviation (Section 8)? The paper concludes with a summary and discussion (Section 9).

2. Definition, terms and key features

2.1 Definition

To my knowledge, the literature so far does not formally define PES, which contributes to some conceptual confusion. For our field work in Bolivia and Vietnam, we used five relatively simple criteria to describe the PES principle. A PES is:

1. a *voluntary* transaction where
2. a *well-defined* ES (or a land-use likely to secure that service)
3. is being 'bought' by a (minimum one) ES *buyer*
4. from a (minimum one) ES *provider*
5. if and only if the ES provider secures ES provision (*conditionality*).

First, PES is a voluntary, negotiated framework, which distinguishes it from command-and-control measures. This presupposes that potential ES providers have real land-use choices, something which in Vietnam, for instance, typically was not the case: payments here were more to be seen as in integral part of the predominating command-and-control system (Wunder, The, and Ibarra 2005).

Secondly, what is bought needs to be well-defined — it can be a directly measurable service (e.g. additional tons of carbon stored) or land-use caps that are likely to help providing that service (e.g. "forest conservation provides clean water"). In fact, here the word "likely" hides important scientific insecurities and popular perceptions. Especially hydrological services are often based on beliefs rather than scientific proof (e.g. "forest cover always increases water availability") (Kaimowitz 2004). Also, external factors can interfere; Nature is not always 'well-behaved'. For instance, even if forest conservation indeed increases the likelihood of clean local water provision, this increase may be subordinate if the general frequency of tropical storms and flooding is high, thus dominating water-quality outcomes. Payments that build on scientifically unlikely relationships, on likely relationship being unlikely to affect significantly the desired outcome, or on what has outright been proven to be a myth, might persist over a long time. In many cases, we lack the knowledge base to classify objectively which ES provision cases are real and which ones are 'imaginary'. However, we assume that a poor underpinning of ES will tend to decrease PES robustness and sustainability: the less realistic the scientific basis of a PES scheme, the more exposed it is to the risk of buyers questioning its rationale and abandoning payments.

In any PES, there should be resources going from at least one ES buyer (criterion 3) to at least one provider (criterion 4), though the transfer often occurs through an intermediary. Last but not least, in a PES scheme user payments need to be truly contingent upon the service being continuously provided (criterion 5). ES buyers thus normally monitor compliance, e.g. has hunting, deforestation or slash-and-burn agriculture really been contained in the manner stipulated in a given contract? In developed countries, supporting legal and enforcement apparatus can create the conditions for once-off payments to provide future ES flows, for instance in permanent easements (e.g. Bayon 2004; Sokolow and Zurbrugg 2003). But in developing countries, this option is usually lacking — more so in agricultural frontier areas with weak governance. This feature implies that in the tropics PES normally need to be *periodic* (often with an infinite horizon) and tied to *monitored compliance*. Service buyers thus need to be able to withdraw from a PES contract if they do not get what they paid for. Conversely, service providers may also have an interest in flexible contracts, so they can pull out (or alter the terms) of a PES scheme if changing context conditions induce them to do so.

How many PES schemes with these five basic principles can one find in the tropics? In our assessment of two countries, Bolivia and Vietnam, no single scheme satisfied all five criteria, although several satisfied more than one (Robertson and Wunder 2005; Wunder, The, and Ibarra 2005). For instance, watershed payments were being made, but there was no free land-use choice (criterion 1). The more precise nature of the service provided often remained fuzzy (criterion 2). The money often came from donors rather than from service users (criterion 3). Conversely, sometimes users were charged, but the money had not been spent so far to pay potential ES suppliers (criterion 4).

However, clearly the hardest criterion to meet is conditionality (criterion 5): many initiatives are loosely monitored or not at all, payments are up front instead of periodic, and they are made in good faith rather than being truly contingent on monitored service provision. The business-like feature of contingent conservation payments raised some resistance in all study countries. In sum, while the number of tropical *PES-like initiatives* is thus considerable — (Landell-Mills and Porras 2002) reviewed 287 such schemes — there are probably very few 'true PES' conforming to the theoretical concept developed in the literature and described in the simple definition above.

If our field search thus produced barely any 'true PES' hits, is it perhaps because the above PES definition was simply too narrow? Historically, many schemes of reforestation and soil-conservation subsidies were clearly justified in part by environmental services, even though the provision of the latter typically was assumed rather than monitored. Alternatively, one could choose to define PES by the additive meaning of the terms it contains: any "payment" somehow intended to promote "environmental services" could be PES. In addition to reforestation and soil-conservation subsidies, things like salaries for local protected-area guards, wages for people working in conservation projects, and certainly all ICDPs would qualify. If, nevertheless, I prefer to maintain the above 'pure PES' definition, it is out of a belief that these five principles represent something new — a more direct approach that deserves to be tested on its own terms, before being added to the big pool of well-tested environmental spending types. Evaluating the different degrees of compliance with these five criteria of specific cases — though sometimes a task with subtle distinctions — can serve as an indicator to what extent these cases truly represent the underlying PES principle.

2.2. Terminology

What terms have been used to describe this type of innovative mechanism? Box 1 summarizes four terms describing the remuneration mechanism (the "P" in PES): "payments", "markets", "rewards" and "compensations". As discussed in detail in Box 1, the choice of term implies what one should expect the mechanism to achieve: Is it the competitive interaction between multiple agents ("markets"), the just and equitable prize for services rendered ("reward"), or the recompense for a cost the service supplier has suffered ("compensation")? This is clearly linked to substantive questions about what situations merit remuneration, to whom, in what 'currency', and how much — questions that will be dealt with in the remainder of this paper. The terms used can also trigger different political and ideological associations, which in turn can influence whether the mechanism is implemented or not (Wunder and Vargas 2005). In the following, we adopt "payment" as arguably the most generic and less ideologically colored term, but the most appropriate choice of label will be case-specific.

The "E" in PES has also been subject to discussion: does it stand for "environmental" or "ecosystem" services? We use the former, assuming a separable nature of different services. The latter probably has a more integral interpretation, implying that multiples services cannot always be broken up into additive components (Scherr, Khare, and White 2004). However, the substantive difference for our purposes is minimal.

Finally, the "S" is probably the least controversial part, given the consensus that we are discussing "services" in the sense of non-material, non-extractive benefits from Nature. One factor of doubt can be how to account for certified 'green' products that are being produced jointly with an environmental service. In some

Box 1. Terms used for the remuneration of environmental services

1. ‘*Payments* for ES’ — chosen here as the most generic term. However, it has a clear monetary association, which can raise ideological resistance (Wunder and Vargas 2005) and can be locally seen as conflicting with the option of in-kind payments (Section 7).

2. ‘*Markets* for ES’ — another widely used term, e.g. by the Katoomba Group and IIED. The notion is not only of a prime role for economic incentives, but also multiple actors, choices, and competition to some degree. Such markets do exist in some developed countries, but in developing countries they seem remote. Market mechanisms face general restrictions in developing countries, but in addition, the localized nature of eco-services often limits competition on the supply side, sometimes creating *de facto* monopolies. For instance, urban water users cannot just choose different upstream neighbors, or a private nature reserve protecting a targeted endemic species cannot be simply substituted by another area. Single-buyer, or ‘monopsonic’ schemes are also quite common, such as water companies, breweries, electricity firms, or tourism operators. Many schemes are thus bilateral agreements between one buyer and one seller — but not ‘markets’. Markets have some desirable features in terms of society’s resource allocation, so they are desirable long-term goals in some cases. But when the transaction costs of schemes are high, as with watershed protection, striving for multiple buyers and sellers might not be attractive. Our research in Bolivia, Vietnam and elsewhere showed that markets can come to be ideologically equated with neoliberalism, creating a political alienation detrimental to promoting PES (Wunder and Vargas 2005).

3. ‘*Rewards* for ES’ — a terminology with an overtone of entitlement and justice for service providers being secured through a transaction: everybody who delivers a benefit should also be ‘rewarded’. This label has, for instance, been used by the RUPES program in Asia (“Rewarding the Upland Poor for Environmental Services”) (van Noordwijk, Chandler, and Tomich 2004). However, this general connotation runs the danger of raising excessive expectations, since services that are neither highly valuable and/or not threatened are unlikely to find buyers (Section 5).

4. ‘*Compensations* for ES’— has been used in a comparative framework (Rosa, Kandel, and Dimas 2003). It refers appropriately to a direct or opportunity cost on behalf of the service supplier, which creates a moral justification and a societal rationality for paying. However, where ‘reward’ implies that everybody who delivers should be paid, ‘compensation’ restricts the scope to those who bear some costs — those who bear no costs do not need to be ‘compensated’. The term could be misleading when providers who suffer costs look not only for recompense, but also for a ‘providers surplus’ — gains from the transaction that exceed their costs and thus make them better off. In a strict sense, cost compensation alone would barely have any poverty-alleviation impact on PES recipients.

Local inhabitant from Zancudo working as a boatman in a tourism operation. The Zancudo community received an in-kind compensation from the Transturi company for not hunting in a prime tourism visitation zone in the Imuya area, Cuyabeno Wildlife Reserve, Northern Amazon region of Ecuador (photo by Sven Wunder).

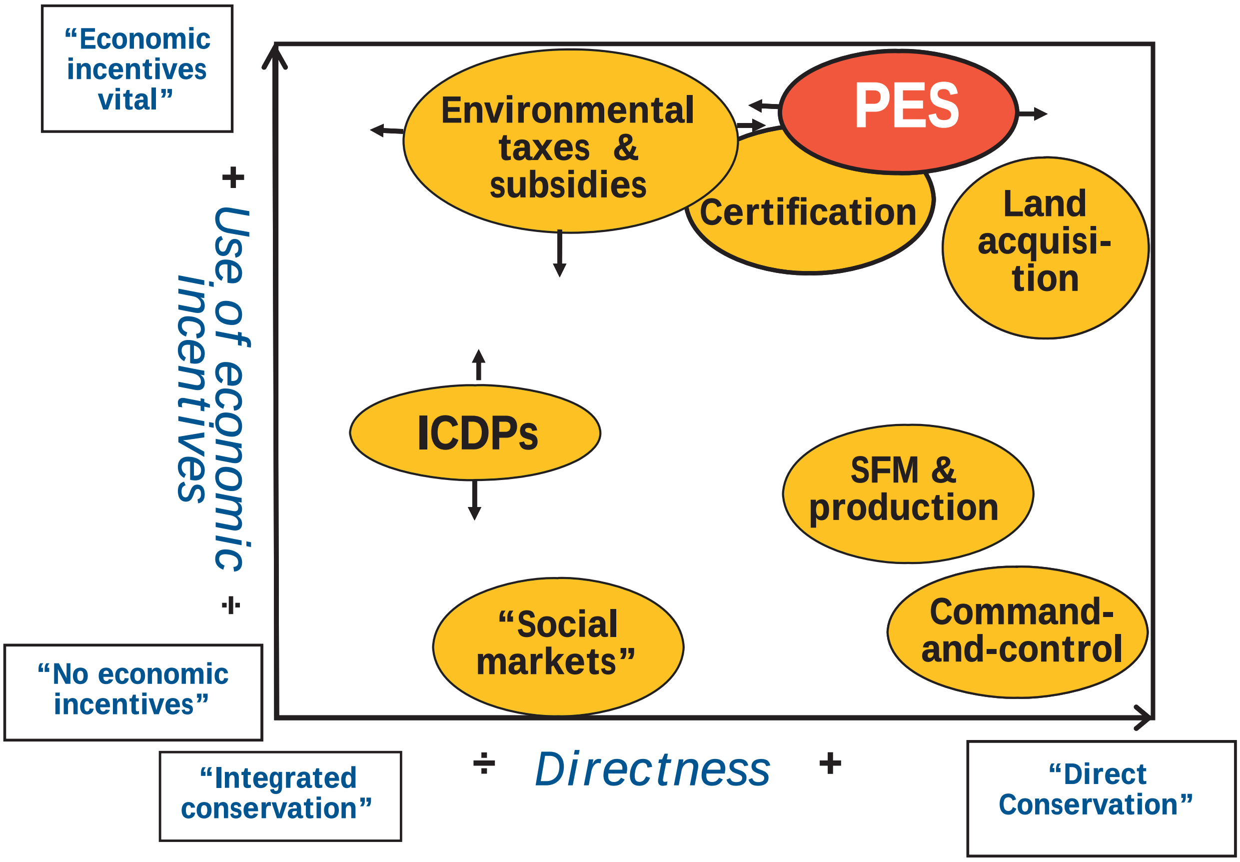

Figure 1. Comparing PES to other conservation approaches

global assessments of the total value of ES transactions, the value of these products is fully included (Scherr, Khare, and White 2004). It might be more appropriate here to count exclusively the value of the green premium, i.e. only the value difference between the ecologically and the conventionally produced good can genuinely be attributed to the ES.

2.3. Key features

What features distinguish PES from other conservation approaches? PES has already been compared with ICDPs in the literature, but a broader evaluation is desirable, including a comparison with other conservation instruments. Figure 1 ranks a set of conservation approaches according to two criteria: first, the degree to which they rely on economic incentives; second, the extent to which conservation is targeted directly rather than integrated into other development approaches. Note that the approaches as described are not mutually exclusive; they could be combined in different conservation strategies.

Command-and-control regulations (including the creation of strictly protected areas) aim rather directly at protecting the resource, without using economic incentives — unless corruption turns regulations into *de facto* unofficial 'taxes'. They are thus located in the extreme South-Eastern corner of the diagram and stand in stark contrast with the voluntary, flexible character of PES. However, PES can coexist with or even enhance command-and-control measures, as in the case of the Kyoto Protocol preconditioning carbon mitigation markets. *Sustainable forest management (SFM)* and similar resource-use improvements also directly pursue conservation by influencing production and extraction processes. Technical modifications are the main instrument, although economic incentives and development mechanisms also can play a role.

In the South-Western cluster, *ICDPs* are by their very nature the opposite of direct. They are non-contingent and explicitly integrate conservation and development concerns, looking for 'conservation by distraction' and 'less poverty — less degradation' effects. Their holistic efforts include building local institutional capacity, generating benefits to 'buy' local goodwill towards conservation and influencing government policies. Economic incentives in ICDPs play a variable role. Unlike PES, ICDPs require investments in alternative production forms. They are 'projects' or 'programs', often surrounded by mutual expectations of holistic (sometimes: paternalistic) interventions. In contrast, PES are designed as 'transactions' that may be sensitive towards local development dynamics, but without pretending to hold community hands — it is all about selling and buying a service to achieve a more rational land use. Yet, one could also imagine some hybrid forms, such as integrated projects that are financed in a contingent way (Section 9).

In a cluster adjacent to ICDPs, we have "*social markets*" (Heyman and Ariely 2004). These comprise systems of reciprocity and exchanging favors at different social scales. By definition, these systems are non-monetary — and critics argue that introducing PES project tends to jeopardize them (Section 6). Social markets are often traditional systems that have evolved locally over time. Points of leverage for conservation include moral persuasion, social pressure, or promised favors — all factors closely linked to integrated social systems and development processes, rather than to direct conservation.

Obviously, PES belong to the family of approaches making pronounced use of economic incentives (Northern cluster) — in fact, incentives are at the very core of PES. In that respect, PES resemble *environmentally motivated taxes and subsidies*. But the PES approach of 'purchasing conservation' in a contingent way is more direct than most taxes and subsidies which aim more at changes in broader production and resource-use patterns. Ecological price premiums linked to *product certification* can be seen as overlapping with PES (see below, this section). The 'ecological VAT' program practiced in several Brazilian federal states is another border case between PES and fiscal environmental instruments: tax transfers being made from federal states to municipalities, which are rewarded for the size and quality of conservation areas (May et al. 2002; Grieg-Gran 2000).

Land acquisitions for conservation and similar measures such as buying out logging concessionaires are one-off solutions aimed at eliminating environmentally problematic actors. PES instead try to make deals to work with these actors. PES normally do not involve changes in land tenure. PES might thus be cheaper and more adaptive, local people need not be expelled, and the conservation buyer does not need to worry about enforcing land tenure. Conversely, setting up and running a PES scheme could over time require higher transaction costs (negotiation, monitoring, etc.) than once-and-for-all land purchases, and there is always a risk that the landowner cancels or violates the PES deal. Notably, land purchases are fully direct; they have no posterior integrated conservation-development dimension. In turn, to the extent that receipts from PES change local livelihood dynamics through income, consumption, labor and land markets, this can either strengthen or weaken conservation — be it by affecting the sustainability of the PES deal itself or through unexpected environmental side effects. These indirect feedback loops triggered by the development dynamics of PES are sometimes forgotten by those who see the PES approach purely as 'direct conservation'.

2.4 Different PES types

PES schemes thus clearly distinguish themselves from other conservation tools, but internally they are also a quite diverse family. In the following, three distinctions will be made: area- vs. product-based schemes, public vs. private schemes, and use-restricting vs. asset-building schemes.

First, PES schemes differ in the vehicles used to achieve conservation or restoration effects. The most common type is *area-based schemes*, where contracts stipulate land- and/or resource-use caps for a pre-agreed number of land units. Examples are conservation concessions (Niesten, Ratay, and Rice 2004; Hardner and Rice 2002), easements, protected catchments, or forest-carbon plantations (Smith and Scherr 2002). Second most common are *product-based schemes*, where consumers pay a 'green premium' on top of the market price for a production scheme that is certified to be environmentally friendly, especially vis-à-vis biodiversity (Pagiola and Ruthenberg 2002). The premium could be for a product meticulously linked to the use or non-use values of pristine habitat (e.g. ecotourism, extractive jungle rubber), for agro-ecological production modes preserving relatively high ES levels (e.g. shade-grown coffee, organic farming) or for ES conflictive production methods using best practice to minimize negative environmental impacts (e.g. certified timber, proposed certification of soy and cattle producers in Brazil).

Cloud forest being protected by the watershed PES scheme in Pimampiro, Northern Ecuador (photo by Sven Wunder).

Second, PES also differ according to who the buyers are. On the one hand, in *public schemes* (e.g. in Costa Rica, Mexico, China), the state acts on behalf of ES buyers by collecting taxes and grants and paying alleged ES providers. On the other hand, *private schemes* are more locally focused (e.g. watershed schemes in Pimampiro-Ecuador, Valle del Cauca-Colombia, Santa Rosa-Bolivia, and basically all carbon schemes), and buyers pay directly. Public schemes are generally larger in scope and have the state providing legitimacy, which many private schemes struggle hard for. On the downside, public schemes can become overloaded with side objectives catering to voters rather than supplying ecological services proper, they are less flexible vis-à-vis targeting of strategic ES sellers, and they tend to be less efficient in securing additional ES provision (Section 3).

Finally, "use-restricting" PES schemes reward providers for *conservation* (including natural regeneration) for capping resource extraction and land development; or for fully setting aside areas, such as for protected habitat. Here, landowners are paid for their conservation-opportunity costs, plus possibly for active protection efforts against external threats (Hardner and Rice 2002). In contrast, in "asset-building" schemes PES aim to restore an area's ES, for example (re)planting trees in a treeless, degraded landscape. Conservation-opportunity and protection costs aside, PES may here also compensate the direct costs of establishing ES, often through investments within agricultural systems (Pagiola et al. 2004). Whether PES is an economic rent for basically "doing nothing", or at least in part a reward for actively improving ES, has some implications for rural employment (Section 8).

3. How to evaluate PES efficiency?

If you go to the market and buy a fish to cook for lunch, it may eventually taste better or worse than expected — but basically you know in advance what you buy. If you buy an ES, whether you get what you paid for is much less self-evident. Since the ES is provided over time, you always need to consider what would hypothetically happen without your PES scheme, i.e. you need to construct some *counterfactual ES baselines*. The first and prime question to ask is whether the PES scheme has a sufficiently large, additional effect vis-à-vis that baseline: Does it really make a difference? The *additionality* question has been much debated for forestry's status in the Kyoto Protocol's Clean Development Mechanism (CDM). Only reforestation and afforestation are currently accepted as truly additional and thus eligible for carbon credits, while protecting forests that would disappear in a no-PES baseline is not. Figure 2 illustrates three fundamental baseline scenarios.

Current CDM rules are an example of a static baseline where (a): forest carbon stocks are assumed to remain constant vis-à-vis a *laissez-faire* historical scenario. The difference is then attributed to specific interventions that qualify for carbon credits. Critics argue that in many tropical countries deforestation is an integral part of development, implicitly adopting a dynamic, declining baseline (b). A halt or even slow-down in deforestation ('avoided deforestation') would then qualify for additionality and carbon credits. However, regions or countries in advanced stages of their 'forest transition' process also regain forest cover as a result of land-saving and forest-valuing development features, even without specific interventions. An example of this improving baseline (c) is Costa Rica, where a historical turnaround of deforestation started in the early 1990s (between the 1987 and 1996/97 forest assessments), i.e. *before* the PES system was implemented from 1996 onwards.

This shows that the choice of baseline is tremendously important for PES efficiency. For instance, the Costa Rican PES system builds on static baselines, but if in reality forest cover would increase even without PES, it means the system is likely to pay for reforestation or conservation that would have happened anyhow — a suspicion that seems substantiated by case studies of PES-receiving forest owners with holiday cottages who would be unlikely to clear or degrade their forest (Miranda, Porras, and Moreno 2003). Conversely, current CDM rules bypass important opportunities to slow down forest loss through economic incentives, due to the use of a rigid static baseline. Adopting the wrong baseline can thus lower PES efficiency, or, in the worst case, waste all the money spent: if no *de facto* change in behavior is achieved, no additional environmental services will be produced.

Two other PES efficiency concepts are relevant whenever the intrinsic scope of the ES exceeds in time or space the scope of the specific PES intervention. This is highly relevant for carbon sequestration, which is a global, long-term service enhanced through a series of interventions specific in time and space. If a carbon PES scheme finances reforestation in a certain area, but this directly causes deforestation pressures in a neighboring area, then the PES scheme had a high *leakage*: it achieved high additionality only for the project area, but not for the broader, global goal. If after the scheme's termination all the reforested trees are cut down immediately for firewood, the scheme's *permanence* would be lower than if the trees were left standing. Leakage and permanence are also relevant concepts for watershed, landscape aesthetics, and biodiversity goals, depending on how focused these goals are in time and space, compared with the scope of the specific PES interventions.

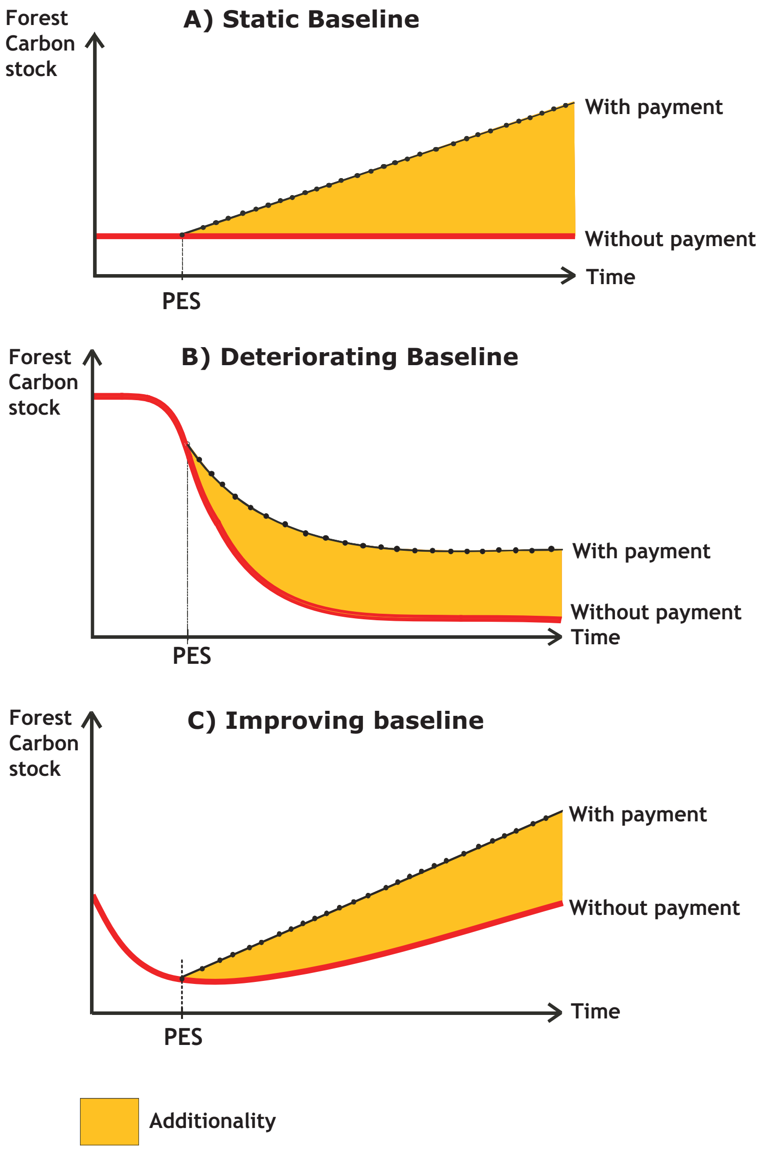

Figure 2. Three different PES baselines

Pine plantations on community lands planted through the PROFAFOR carbon sequestration program (Forest-absorbing carbon-dioxide emission forestation program in Ecuador). High Andes near Guamote, Southern Ecuador (photo by Sven Wunder).

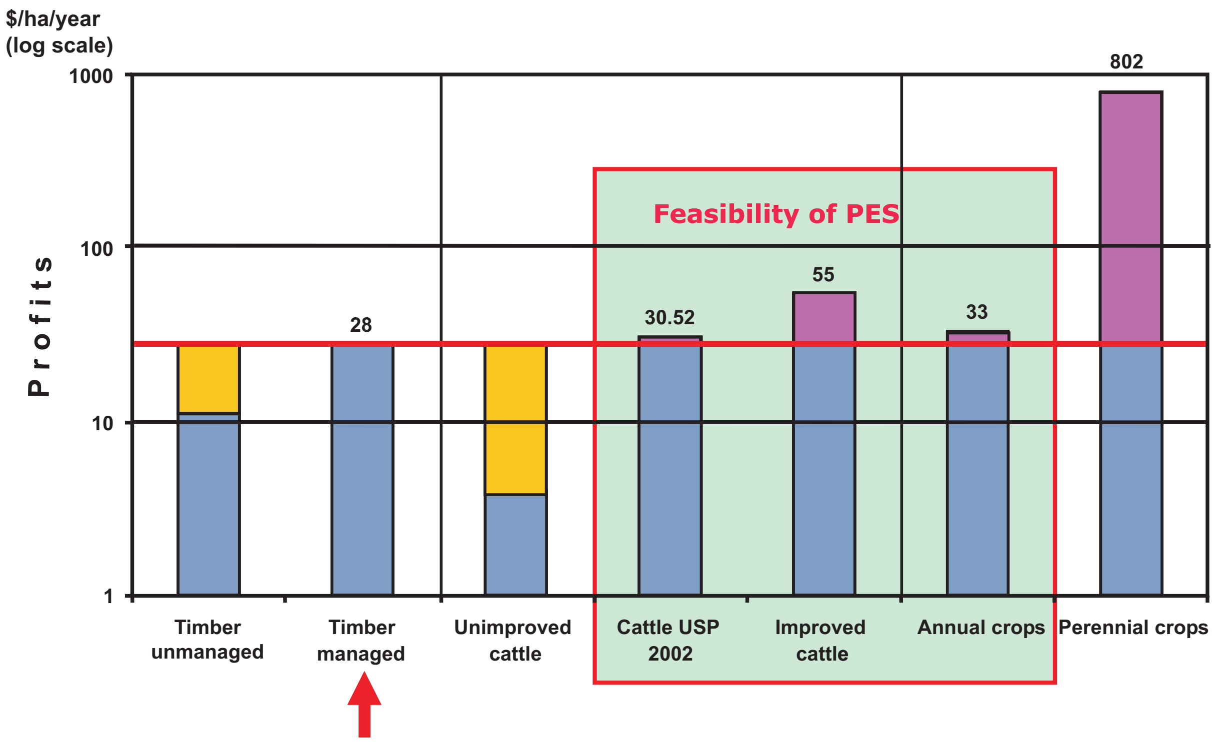

Figure 3. Profitability of land uses compared. Paragominas county (Brazil)

Source: Almeida and Uhl (1995); Margulis (2003)

Many practical issues must be considered when deciding how to fix a baseline and evaluate additionality. Combining implementation with research and systematic data collection would be particularly suitable in this case, as happened with the RISEMP project in Colombia, Costa Rica and Nicaragua (Pagiola et al. 2004). If one just observes outcomes in areas with performance payments, one cannot discern the PES impact separate from omitted variables such as recipient's location, schooling, conservation attitudes, etc. Randomizing the payment could help control for this bias, for example randomly selecting from a pool of households potentially eligible for PES (R.Godoy, pers. e-comm., 7 April 2005). In the RISEMP project, groups were designed to control not only for whether PES payments were made, but also whether technical assistance accompanied the payment (J.Gobbi, pers.comm., Turrialba, 9 February 2005).

4. Using PES for which land-use scenarios?

In interpreting the emerging theoretical literature advocating PES schemes (Ferraro and Kiss 2002; Ferraro and Simpson 2002; Ferraro 2001), one might be tempted to believe PES has an *absolute advantage* over other approaches, specifically ICDPs. But as mentioned above, third instruments may also be available, and their conservation-efficiency ranking may be highly context-specific. Conservation's opportunity cost, i.e. the returns to alternative land uses, are one discriminating factor determining where PES is applicable. Figure 3 provides a numerical example of land-use profitability from Paragominas County in the Brazilian Amazon, which we can use for discussion.

Let us for the sake of simplicity assume different ES buyers had jointly determined that managed timber production would be the most desirable land-use option in Paragominas, maximizing different ES while providing a minimum productive income to land users. They are now pooling resources for a bundled PES scheme offering land-use incentives to shift to managed timber production. Compared to the net land-use profits of US$28/ha/yr from managed timber (horizontal line in Figure 3), some activities have higher, others lower economic returns. For which ones would a PES-led substitution strategy likely work?

For activities with lower returns already (unmanaged timber, unimproved cattle ranching), a PES subsidy for managed timber production is unlikely to matter. Land users already would have changed to this higher-yield activity without PES, but are probably constrained by other factors (access to credits, technology, infrastructure, know-how, etc.) which are not directly related to recurrent land-use profitability.

At the other end of the spectrum, perennial crop cultivators receive US$402/ha/yr - a per-hectare economic return no less than 28 times higher than managed timber. Shifting them from perennials to timber production would require an astronomical subsidy, likely to by far exceed potential conservation funding and the economic value of the incremental ES gained. However, for activities *marginally more profitable* than the desired land use (i.e. improved ranching and annual crops in the ‘feasibility rectangle’ in Figure 3), a PES subsidy could effectively alter breakeven points and induce the desired shift towards sustainable forestry.

By implication, a PES system is likely to be most cost-effective in the middle range of activities marginally more profitable than the desired land use. For less profitable activities, PES is likely to be irrelevant; for substantially more profitable activities, finite funding tends to fall short of the compensation needed.

Obviously, there are some caveats in using this example to represent the complex real world. Producers might not only look at average annual profits, but also at other factors such as risk, price fluctuations, expected future returns, legality of use, and security of land tenure. Where land is plentiful, like in the Amazon, they may also look more to returns per labor input or per capital unit invested, rather than per land unit. ES buyers aiming to protect existing, threatened services in use-restricting schemes (e.g. biodiversity set-asides) may need to anticipate emerging threats and future rises in opportunity costs — if they react only to changes that have already occurred, the service may already have been irreversibly lost (see next section).

On the other hand, this simple example also has some robust practical lessons. For instance, in the nascent Brazilian PES program “Proambiente”, perennial crops are planned to be promoted, among other things by providing PES-subsidized credits. But as Figure 3 showed, in terms of average returns perennials are already extremely profitable, so PES-reduced recurrent capital costs and marginally higher returns are unlikely to make much difference for most land-use choices. Perennials may be more effectively promoted by reducing disease risks, price fluctuations, credit constraints and other barriers to entry. It may well be that traditional integrated project approaches, targeted at the multiple non-income constraints to adopting perennials, are more suited for this specific task than PES.

Contrary to common belief, it is often not necessary before PES establishment to do a full economic valuation of ecosystem services on the buyer side, and an economic study of farming system returns on the provider side. In principle, any price the two parties jointly negotiate can be ‘the right price’ — just as right as the price I negotiated for the fish in the market. For carbon sequestration, a referential market price already exists. However, some back-of-the-envelope calculations can certainly help each side to strengthen their negotiating positions, or even to pre-determine whether a PES scheme is a realistic option or not.

An example can illustrate this. In a watershed PES pilot scheme in Santa Rosa, in the buffer zone of Amboró National Park in Bolivia, a relatively low annual PES (in-kind value of about US$7/ha/yr) was offered to landowners to set aside forests for conservation. Opportunity costs varied according to slope, soil fertility and access, but would be up to an order of magnitude higher. When PES rates were so uncompetitive, surely nobody would join the conservation scheme? But some farmers did, mainly to cash in a rent for forests that they would have conserved anyway. While the scheme made important headway in locally piloting the basic PES principle, it probably gave little ES additionality, so far at least (Robertson and Wunder 2005).

In this type of situation, a basic assessment of opportunity costs can help set PES rates competitively, and possibly target limited PES resources to those areas where they can really make a difference. As ongoing research with our partners in Costa Rica tentatively indicates, significant efficiency benefits may be gained by changing from the current flat PES per-area payments to rates differentiated in space and tailored to the variable ES provision potentials and opportunity costs of different forest landscapes (T.Wünscher, pers.comm., Turrialba 10 February 2005) — although eventually there may be major political-economy obstacles to implementing differentiated payments in a public scheme.

5. Efficiency or fairness?

In conservation and rural development circles, many look to PES as a source of just reward for poor rural dwellers who take care of the environment and continuously 'produce' ES — until now, for free (Shilling and Osha 2003; Rosa, Kandel, and Dimas 2003; van Noordwijk, Chandler, and Tomich 2004). However, from an efficiency point of view, only those who constitute a credible threat to ES provision should be paid. Let us return to the Brazilian Amazon for an example.

First, the remote federal states of Amazonas and Amapá have recently declared large areas to be protected, and federal government representatives have also expressed hope that their pro-conservation policies will be rewarded with international PES resources. Yet, deforestation rates in most of these remote areas remain very low, indicating that the development frontier has still not reached them. Why would ES buyers want to pay for conserving forest that is not currently threatened, and thus would be conserved anyway (negligible additionality)? If land-use pressures are distant, how far-sighted should a PES initiative be?

Second, a state like Mato Grosso is at the other end of the spectrum, aggressively promoting the expansion of ranching and soy. High deforestation rates reflect land-use threats and high conservation opportunity costs, especially in terms of soy beans' high profitability. The economic, biophysical and political context induces rapid forest conversion. There are thus many good reasons to intervene, but would even large-scale PES be sufficient to change the process? Or is the system with its economic forces too much pre-geared to a scenario where forests will rapidly decline no matter what, constrained only by capital shortages, road infrastructure, time, and possibly legal constraints? Is there hence eventually greater hope for conservationists in pursuing command-and-control measures here, such as enforcing the Brazilian legal restrictions mandating a minimum percentage of forest retained on farms?

Third, a federal state like remote, forest-rich Acre constitutes an intermediate example. Its self-declared *Governo da Floresta* (Forest Government) has been innovative in socio-environmental legislation and implementation, with a pro-active grassroots movement; the mix has much appealed to foreign donors. At the same time, emerging economic factors like road projects linking Acre to neighboring Bolivia and Peru and expanding timber and beef demand, are all increasing pressures on forests and accelerating clearance rates. Is this intermediate setting, with foreseeable major threats and rising opportunity costs, perhaps the most favorable scenario for PES application?

Obviously, there are no easy answers — not least because the three states internally include a high variety of sub-scenarios. Biodiversity buyers might best keep a diversified portfolio, acting on both current and projected threats. PES schemes need to strike some balance between short-run efficiency and fairness, the latter influencing long-run viability. However, what seems certain is that neither the 'ecologically noble savage' who fully safeguards his or her environment, nor the impoverished farmer too poor to do significant ecological damage, will emerge on the scene as major ES sellers. They simply do not constitute a credible threat, so paying them creates zero additionality — it makes no difference. Is that unfair? Perhaps not, since they also do not suffer conservation opportunity costs from forgone development. The ideal ES seller is, if not outright environmentally nasty, then at least potentially about to become so.

On the other hand, current threats are not the only relevant indicator — and sometimes threats are only unambiguously revealed when it is too late. Applying PES to target agents and areas where threat is *projected* to emerge could be an effective insurance against future degradation. CIFOR has adopted this logic trying to develop a community conservation concession scheme in Setulang village, East Kalimantan, Indonesia (Wunder et al. 2004). While most neighboring villages have sold out their forest to timber companies, Setulang has preserved five thousand hectares of primary lowland forest, mainly to protect local water supply.

However, the bids from logging companies are rising, and the internal village conservation consensus is endangered. In this situation, an external biodiversity payment to local people for not selling logging rights could help sustain the village consensus. It can also help them cover the costs of more effectively protecting the forest against logging companies' external threat. PES probably has a high potential for achieving real and additional conservation gains in situations where decisions are still 'on the edge', especially when it is in a use-restricting scheme with ES being threatened by irreversible loss (e.g. biodiversity). Once the balance has tipped and the community has sold off logging rights, it is obviously too late for PES to have any impact.

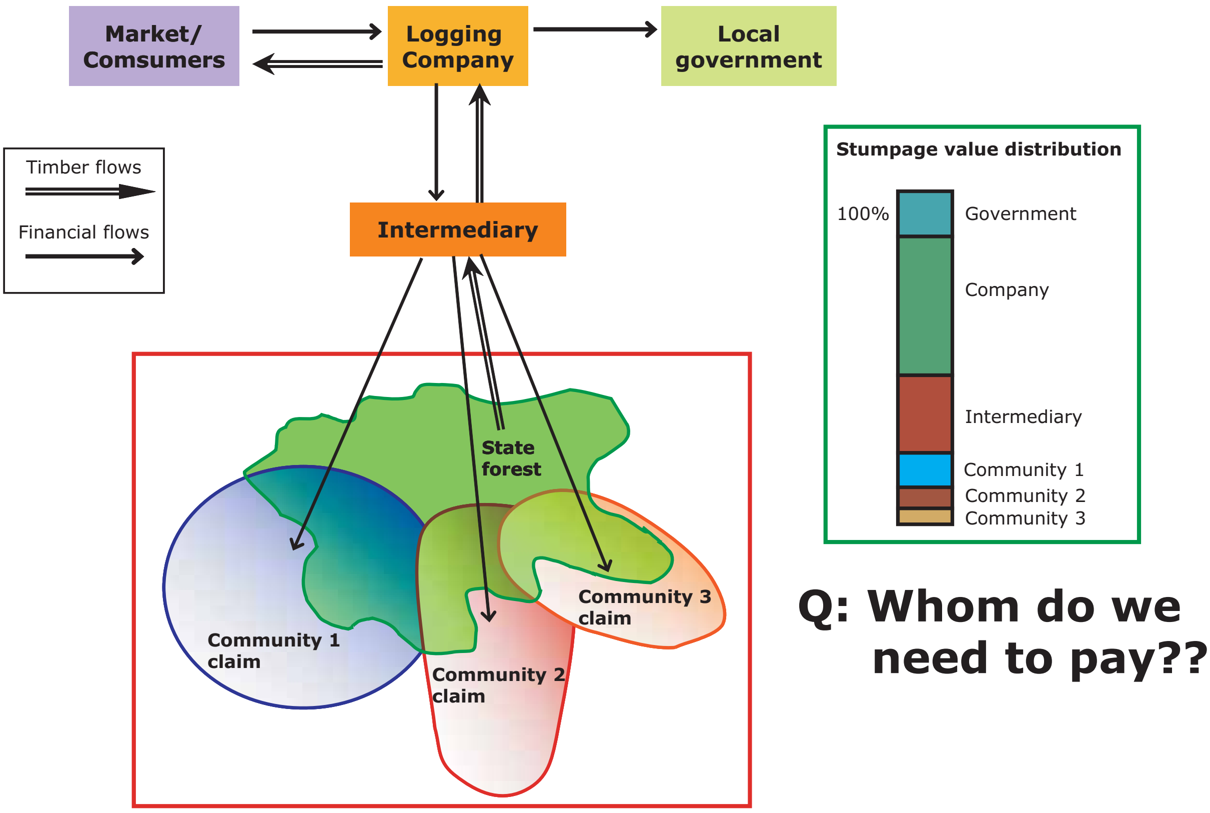

Figure 4. Buying out logging rights for conservation in Indonesia

CIFOR is supporting the village of Setulang, East Kalimantan, Indonesia, setting up a PES scheme to avoid logging of the village's lowland forest and find financial support to set it aside for conservation (photo by Yani Saloh).

6. Whom to pay?

This section will deal with three concerns in selecting possible PES recipients: the value-added chain, insecure land tenure, and illegal resource use. The first issue relates to the vertical distribution of opportunity costs. Consider the Setulang case (Wunder et al. 2004). For a biodiversity PES to be politically acceptable, one needs to compensate a critical mass of decision makers that would otherwise benefit from the biodiversity-threatening activity, logging. Figure 4 shows the approximate distribution of timber-extraction benefits, combined with the financial and commodity flows. Logs are being extracted from *de jure* state forests, the use rights of which are *de facto* claimed by different local communities through traditional land rights (*adat*) that in turn are generally recognized by the post-Suharto Indonesian state.

However, claims are overlapping between communities, and their negotiation power varies — causing their shares in total timber rents to diverge (right-hand bar). Yet, other agents such as intermediaries (fees), timber companies (sales value), local government (taxes, bribes) and probably timber consumers (consumer surplus) are currently getting the lion's share of net profits, and would thus have the most to lose from conserving forests. Should all these actors be compensated in a PES scheme?

From an efficiency point of view, one would want to compensate enough (not necessarily all) actors to form a resilient conservation alliance, but selecting only among those who have credible site-specific claims. Generally, consumers, intermediaries and timber companies need not be compensated, as long as their interests remain 'mobile'. Unless they buy, rent or forcibly occupy an area, they cannot make site-specific claims. On the other hand, communities acting as direct local guardians have a vital stake, and do need to be compensated. Yet, if the community is too weak to protect its land from loggers, then a PES scheme has no foundation. Local government, recently strengthened by decentralization, can be a catalytic actor that may need to be rewarded, although there are pros and cons.

Note that for a PES to be 'fair', one might want to compensate all losers, but in this specific case across-the-board compensation would be prohibitively expensive. Note also that buying conservation for a relatively low price, aligned only with local people's opportunity costs, could eventually trigger losses in national income by forgoing large timber rents paid to non-local actors (Section 8). Whom exactly to pay is a question of negotiation, political feasibility (which includes perception of fairness), legality (particularly vis-à-vis land tenure) — and possibly also of ethics, since some actors may lose illegal revenues, corrupt payoffs, and iniquitous profits.

Second, many land users in the tropics do not have formal land titles, especially in agricultural frontier areas. Can and should these people receive PES? The main preoccupation for private ES buyers should not be the *de jure* land rights, but *de facto* land- and resource-use control capacities. Informal landowners whose land claims are widely recognized and respected can be efficient ES provider since they can control access; someone whose tenure is perceived as insecure and weak cannot, since external agents can occupy the land or harvest the resources. In disaggregating the complex concept of tenure rights, the 'right to exclude' layer is particularly decisive for ES providers' efficiency. The more open the access, the less adequate the scenario is for PES.

Third, land tenure issues aside, does the legal status of resource uses matter for selecting PES recipients? Many legal caps on tropical land uses are weak (e.g. declared but not enforced 'protection forests'), and some forest products (e.g. wild animals, logs, charcoal) are globally to a large extent illegally harvested. Should these resource users receive PES to defer their threats of illegal extraction? If so, would legal actors be perversely encouraged to drift into illegal activities, too, in order to qualify for PES — or just to protest against an unfair system? Could PES eventually come to endorse crime (Vogel 2002)? There is certainly a game-theoretical foundation for environmental blackmail (Mohr 1990), and perverse incentives have been a real concern for some PES schemes (Pagiola et al. 2004).

Again, there is no one-size-fit-all answer, and a pragmatic approach is recommended. In many cases, a carrot-and-stick approach is rational, i.e. to supplement weakly enforced laws with PES compensations partially covering compliance opportunity costs — especially when recent top-down protection declarations can be said to have been unfair vis-à-vis existing local land claims. Even in the well-established Costa Rican PES system, farmers are paid *inter alia* for not deforesting, although deforestation actually is illegal.

However, since PES presuppose *de facto* free land-use choices (Section 2), they are normally not an adequate tool to strengthen existing protected areas, although there can be exceptions. To the degree that protected areas have been relatively efficient in halting deforestation (Bruner et al. 2001), squatters should not be paid to stop expanding further into national parks — unless it is bound to be a 'paper park' without any command-and-control potential. Paying squatters could backfire by 'giving away hostages' in the struggle over protected land, e.g. by attracting new squatters looking for their 'just reward'. Ultimately, the decision whether to offer carrots depends on a realistic assessment of how far the stick alone will take you.

More broadly, PES implementation should be preceded by an efficiency analysis of existing approaches and motivations for ES provision, and how a PES scheme would likely affect them. Will payments always increase recipients' effort? At least part of the psychological literature claims that extrinsic rewards can undermine intrinsic motivation (Deci, Koestner, and Ryan 1999), such as a community's self-interest and pride in forest conservation. Monetary rewards could also debilitate pre-existing social markets (Section 2), i.e. societal ties and reciprocity arrangements. Apparently this is especially a danger as long as payments remain small (Heyman and Ariely 2004). At worst, conservation effort in exchange for a low monetary PES could be lower than for 'no payment'. This is noteworthy, since in most cases PES amounts paid have actually remained low.

7. How to pay?

Payment methods also matter for PES efficiency. A cynical ES buyer might be indifferent about the mode of payment, as long as the provider signs the contract. But the contract's sustainability may eventually depend on the unforeseen development effect of payments on household incomes, changes in consumption, and demand for land and labor. Also, these changes may have environmental side-effects on conservation, beyond what is stipulated in the contract. So it is advisable to *ex ante* think about (and even experiment with) different payment modes, including the cash vs. non-cash selection and the periodicity of payment.

Economists often think of cash payments as the most flexible and thus preferable mode. Cash will be most appropriate when ES suppliers forgo cash income to comply with a PES contract, e.g. reducing a planned expansion in cash crops to conserve a forest area vital for watershed protection. Indeed, in this situation ES suppliers could hardly be expected to accept non-cash PES benefits exclusively, since cash is exactly what they lose from conservation.

Many development practitioners are generally hesitant to advocate cash transfers to rural communities, since they doubt the ability of cash to create sustained local welfare. Cash may increase myopic spending (alcohol, luxury goods, etc.) and cause social distress. At the other end of the spectrum, some argue that regular cash transfers are more effective in alleviating poverty than in-kind contributions or development projects. For instance, in two recent Mozambican cash-transfer programs, flood victims and demobilized soldiers have used their money wisely, administrative costs were very low at 5-10%, and the poverty-alleviation impact was impressive (Hanlon 2004).

A PES field example can illustrate the viewpoints ranging between these two extremes. Table 1 sums up different attitudes from interviews in the Santa Rosa watershed (Bolivia) vis-à-vis the pros and cons of receiving PES in the form of beehives (the current in-kind mode) versus cash (as hypothetical alternative) (Robertson and Wunder 2005). The recipients originally negotiated a contingent transfer of beehives, combined with technical assistance for beekeeping. As one PES-enrolled farmer explained, "If I receive cash, I know I will spend it right away. Instead, I want these payments to create something that lasts." This statement indicates not only reluctance to receive cash, but also recipients' expectations of 'integrated' (often, paternalistic) interventions: the mediating NGO is assumed to deliver a readymade, complete 'package' of benefits. This may well be a rational preference if

Table 1. Perceived advantages and disadvantages of two PES payment modes in Santa Rosa (Santa Cruz, Bolivia), Fundación Natura. Cash and in-kind transfers compared.

Beehive pros/Cash cons	Cash pros/In-kind cons
- Some recipients reject money — it would be spent rapidly and leave no long-run benefits	- Some recipient little skilled and interested in beekeeping, thus losing benefits
- Paying cash "smells" more like losing property rights — whether that fear is rational or not	- Beehives are inflexible assets to sell, compared to animals or equipment
- Honey is a useful subsistence product	- Beehives are inflexible assets to subdivide, compared to cash
- Beekeeping includes an incentive to protect forest as bee habitat	- Extra training costs for implementing NGO
- Demonstration effect of bees and the sweet taste of honey give PES implementers more goodwill than a corresponding cash transfer	- Extra costs for recipients to benefit — beekeeping demands labor inputs

local capacities for saving, investment and entrepreneurship are limited. Other recipients said honey was a useful subsistence product, and receiving beehives caused less fear over land expropriation than cash transfers, whether such fears were rational or not.

For the NGO, the need for bee habitat provided an additional local incentive for conserving the forest. Also, the beehive 'demonstration effect' was claimed to bring more mileage than tiny corresponding cash payments would do. This is supported by psychological science claiming that low-value, in-kind payments can be more effective than low-value cash payments in stimulating effort, since recipients are more likely to view in-kind transfers as compatible with reciprocal exchange and "social markets" (Heyman and Ariely 2004).

However, local opponents wanting cash instead stressed the beehives' inflexibility as an asset, as well as the labor and skill requirements, implying that less-dedicated beekeepers would receive low or zero returns. The NGO training in beekeeping also constitutes an extra cost. Some recipients foreshadowed they would *sell* the next hives to those specializing in bees — thus creating an 'intra-village secondary market' exchanging bees for cash. Others said they would prefer in-kind alternatives, e.g. barbed wire to fence off their land and strengthen tenure. Unless it poses high incremental administrative costs, one could offer a menu of payment modes, even in the same village.

This small example shows that one is well-advised to investigate in advance what mode local people favor. Their preferences might vary across villages, families and even individuals within families, so that a customized approach is desirable. Recipient gender aspects should also be monitored, and in some cases collective rather than individual contract may be preferable (Section 8). In terms of periodicity, it is often desirable to mimic other regular income flows with small, frequent payments — even if compliance monitoring is done only once a year. This may be particularly relevant if cash payments are applied, and temptations for rapid spending are substantial. But one has to find out case by case what is most likely to increase welfare. Some recipients will prefer in-kind options, but cash-poor communities may clearly prefer cash. PES implementers should overcome the paternalistic prejudice that local people are generally unable to administer money going into their pockets.

Finally, it has been suggested that PES agreements could include contingent transfers of infrastructure, such as building a school or a road, or giving basic resource rights to local people, such as formal land tenure (Rosa, Kandel, and Dimas 2003; van Noordwijk, Chandler, and Tomich 2004). The problem here is that large or irreversible up-front benefits are dubious incentives for a continuous supply of contracted services over time. How can one credibly sanction non-compliance — a crucial concern for any contingent agreement? Possibly one could tie compliance to the running *maintenance* cost of infrastructure, e.g. to the costs of keeping a school or a road open. But even so that road maintenance might be taken over by a logging company or an agricultural investor promoting the exact opposite of the land use ES buyers had looked for. These types of incentives are thus generally more apt for ICDPs than for PES schemes. It makes extremely bad headlines for a conservation organization to come and destroy the locally built school or road, or to deprive people of their newly won land rights, just because they happened not to honor their side of the PES bargain.

8. Pro-poor PES?

At a time when overseas development assistance is increasingly focusing on poverty alleviation, it is no surprise that fads like PES are scrutinized for their potential to achieve this goal. Much hope exists that poor ES providers (e.g. remote upland farmers) can raise their incomes by receiving PES from the allegedly richer ES buyers (e.g. urban water users); indeed some donors are only interested in PES for their hoped-for, pro-poor effects.

Conceptually, it is convenient to look at three poverty-related sub-question (Grieg-Gran et al 2005):

1) *Participation*: what access to and 'market share' in PES schemes can poor potential ES providers compete for?
2) *Effects on ES sellers*: To the extent poor providers do get access, how does PES participation affect their livelihood?
3) *Effects on non-sellers*: How does PES affect poor people not selling ES (non-participating farmers, poor ES users, product consumers, landless laborers, etc.)?

8.1 Access to PES participation

Poor farmers seeking to become service sellers face both explicit PES access rules and underlying structural constraints. Explicit PES access rules can favor or disfavor smallholders. Examining six carbon and two watershed projects in Latin America, Grieg-Gran et al. (2005) found a mixed picture. Some rules discriminated against smallholders, such as formal-tenure requirements and the exclusion of agroforestry and silvopasture; others, such as maximum farm-size and targeting of underdeveloped regions, were pro-poor.

There are two major underlying structural constraints. First the 'poorest of the poor' often do not own or control any land, thus directly ruling them out as PES service providers — at least as long as the PES scheme is 'area-based'. PES is thus by its very nature more relevant to 'moderately poor' smallholders. Even those poor who control land often do not have formalized or fully secure tenure. As argued in Section 6, a pro-poor PES scheme could, in most cases, work its way around tenure informality, but effective land-use control is more difficult to enhance by external intervention.

A second structural constraint is the high transaction costs of dealing with many smallholders (or land owned collectively by internally conflictive communities), compared to only a few big landowners (Smith and Scherr 2002). This is exacerbated if there are economies of scale in service provision, e.g. when carbon sequestration requires a process of Kyoto certification with elevated fixed costs. Again, creative scheme design to 'bundle' smallholders, as currently experimented with in Costa Rica's national PES scheme, might alleviate that constraint. 'Bubble projects' for carbon sequestration are a similar cost-saving attempt to make ES commitments for an entire county or region, rather than individual landholders (ibid: 34-5). Obviously, this will move at least part of the transaction costs from the buyer to those seller institutions that have to make sure collective commitment is converted into a sufficient degree of individual compliance. All these measures can thus probably reduce transaction costs, but hardly eliminate the structural constraint proper. Working with three ES providers will almost always be easier than working with three hundred.

Naturally, these 'comparative disadvantages' of smallholders must be weighed against any corresponding advantages. In particular,

Two PES recipients from Nueva America, Pimampiro, Northern Ecuador. Payments are made by the town's water consumers to potect the forest in the headwater of the watershed (photo by Sven Wunder).

smallholders may have significantly lower opportunity costs of their labor and possibly of their (marginal) lands (Costa and Zeller 2003). As long as PES rates per land unit are low, wealthier actors with better capital and technology access and thus higher opportunity costs may not find it worthwhile to compete with poor ES suppliers. These potential advantages of poor ES suppliers may or may not make up for their higher transaction costs. Achieving high smallholder participation rates is also often simpler for highly spatially bound services (e.g. watershed protection) where buyers have to work with whomever occupies the targeted space, whereas the dilemma of transaction costs becomes more apparent for homogenous services with a high degree of spatial mobility and competition (carbon sequestration, in particular).

8.2. Effect on ES sellers

Once poor service suppliers have made it through the eye of the selection needle or have obtained an ES market share, how are they likely to fare? As explained in Section 2, PES contracts are voluntary agreements, so individual service providers can only be made outright worse off if they are being cheated, *de facto* forced into participation, or just surprised by the *ex post* livelihood impacts (e.g. due to under-estimated opportunity costs) and local-economy derived effects (e.g. changing land or labor markets).

Of these possibilities, the latter is maybe the most likely (see discussion below) — though even here PES exit or renegotiation options may still exist. Cases where service sellers are being 'PES trapped' into a lasting negative livelihood outcome could potentially occur, e.g. with long-term land-use deals being signed under asymmetric access to information. But so far, convincing real-world examples of 'PES trap' cases seem to be lacking in the literature. Not only does PES offer an additional source of income in often cash-poor areas with low diversification, the cash flow is potentially also more stable than common alternative sources, such as cash crops with heavily fluctuating output prices. At least, this is the case if the PES program is well-administered and continuously funded, so that ES buyers fully meet their obligations (Pagiola, Arcenas, and Platais 2005).

Even if poor PES providers are likely to be better off, questions remain as to 'how much' and 'in what way' they will gain from participation. As in any commercial transaction, there is an inherent conflict over price between ES buyers maximizing consumer surplus ('biggest conservation bang for the buck') and ES providers boosting their producer surplus (PES payments net of opportunity costs). ES buyers will often, though not always, be in a better negotiating position on account of being fewer in number, more well-informed and initiative seeking than ES providers. For instance, more opportunity-cost studies have been done than willingness-to-pay studies; the buyers thus know more about the sellers than *vice versa*. Increasing organization and information levels among ES providers could sometimes improve their negotiating position.

Notwithstanding possible power asymmetries, in some cases PES come to constitute a noteworthy share of participants' household income — at least as far as we can tell from all the preliminary studies that are available. In Costa Rica, PES payments accounted for more than 10% of family income in more than one quarter of participants (E.Ortiz, cited in Pagiola et al. (2005)); in Virilla PES payments averaged 16% of cash household incomes, but three-quarters of households there earned more than US$820 monthly and were thus far from poor in the first place (Miranda et al. 2003). However, in poverty-struck zones the situation can be quite different. In Costa Rica's Oca Peninsula, a small survey found that of PES recipients that were under the poverty line, the scheme lifted half above it and became the primary household cash income source in 44% of cases (Muñoz 2004). In Pimampiro (Ecuador), watershed-protection payments to poor upland *colonos* made up 30% of recipient households' spending on food, medicine and schooling (Echavarría et al. 2004). PROFAFOR carbon projects in the low-income, high-altitude areas of Ecuador, and the Huetar Norte project in a disadvantaged region of Costa Rica both created some employment in the short run and an important plantation asset for future incomes (Miranda, Porras, and Moreno 2004; Albán and Argüello 2004; Milne 2000). Obviously, all gains reported here are gross figures, since we do not know the size of opportunity costs (income forgone due to PES-induced land-use restrictions), which could be anything from zero to the size of the proper PES payment. Yet, at least for disadvantaged regions, the relative size of income PES contributions seems likely to have been quite significant.

Sometimes PES recipients gain more than just income from participation; non-monetary side benefits can be at least as important (Rosa, Kandel, and Dimas 2003). Three factors stand out here. First, PES participants perceive that PES contracts can help increase land-tenure security vis-à-vis neighbors or squatters by mapping and demarcating the land and by demonstrating an income-generating activity from it. This was found in various Latin American case studies by Rosa et al. (2003), but also in our Bolivia case (Santa Rosa) where forested land is highly threatened by landless migrants from the highlands. Second, PES participants tend to increase their 'social capital' by improving internal organization, e.g. when collective bargaining and action vis-à-vis the service buyers are needed (Rosa, Kandel, and Dimas 2003; Grieg-Gran, Porras, and

Payments for environmental services are most effective in marginal lands where a modest payment can "tip the balance" in favor of conservation. Dry forest area in Costa Rica's Guanacaste region, where pastures are abandoned and enrolled in the PES program (photo by Sven Wunder).

Wunder 2005). Some benefits accrue through PES 'learning-by-doing'; others are provided in advance (e.g. formal training). This social-capital effect is generally to the advantage of local people in their other business dealings with the outside world. Some negative social effects (e.g. tensions between PES participants and non-participants) can also occur. Finally, the PES program works as a strategic 'site propaganda', increasing the visibility of the village or community vis-à-vis both donors and public entities. For instance, in Bolivia we found that some villages involved in landscape-beauty/ecotourism initiatives suddenly found it easier to attract a donor for a health clinic or get recognition from the municipality regarding their long-claimed land-tenure.

8.3. Effect on the non-ES selling poor

What happens to those impoverished people who are not participating in, but still are affected by PES? This is much harder to say, since this residual group is quite heterogeneous, and since impacts are dominated by complex secondary effects that occur in factor markets (land, labor) and in commodity markets (agricultural crops, forest products, etc.). It seems most relevant to look at three impoverished groups: service users, on-site landless people, and off-site actors in the value-added chain.

First, not all ES users are well-off agents. Poor tropical farmers are likely to suffer most from global warming since they lack the means to adapt their farming systems, and are thus particularly helped by mitigation efforts (IPCC 2001). Urban water users in shanty towns often receive their drinking water for free since their taps are not metered; hence they free-ride on any PES-led improvement in water quality or availability. Free-riding ES consumers are thus made better off, yet their slightly more privileged counterparts in the next district who pay for water may well be made worse off, if water fees are rising to finance PES.

Second, in many cases the landless 'poorest of the poor' self-engage (or are being employed) in some of the most ES threatening activities, such as logging-company workers, firewood and charcoal makers, extractors over-harvesting NTFPs (non-timber forest products), or farm hands hired for clearing land and for cultivating converted soils. To the extent that the PES scheme is *use restricting* (Section 2), i.e. it caps planned forest-product extraction or agricultural conversion, groups involved in these activities will lose out in terms of employment or informal-sector income. For instance, PES restrictions were found to be likely to hurt traditional herder and NTFP harvester groups in India (Kerr 2002). In the Santa Rosa case, poor farmers enrolling in conservation PES want to protect themselves from the poorest-of-the-poor migrants coming to the village with the clear aim to occupy 'idle' land. This shows that subgroups of 'the poor' may have internally antagonistic interests vis-à-vis PES implementation. Conversely, if ES provision is *asset-building*, such as justifying planting trees in degraded landscapes with few productive alternatives, this can trigger a net expansion in rural jobs and benefit unskilled rural labor, thus alleviating poverty.

While effects thus can go both ways, in some cases their size can be significant. For instance, laid-off logging and sawmill workers were the main reason for compensatory ICDPs being implemented in the Noel Kempff Mercado Climate Action Project in Bolivia (Asquith, Vargas-Ríos, and Smith 2002). If PES is locally lucrative, it could increase competition for PES-eligible land, possibly to the detriment of the weakest actors' access to that land (Rosa, Kandel, and Dimas 2003).

Finally, PES-induced rural changes can have off-site effects. For instance, the urban poor buying charcoal could be faced with higher prices if an important peri-urban, charcoal-production area is set aside for conservation. Conversely, these higher prices may benefit poor charcoal producers at other sites. If valuable timber rents end up mainly in the capital, then restricting timber harvests can indirectly affect poor people working in, say, the urban service sector stimulated by these rents. Cutting off raw-material supply can have important downstream development impacts — which obviously should be compared to any 'multiplier effects' from PES financial injections. No empirical studies on these linkages exist; in most cases one would expect them to be smaller than on-site effects, but timber rents could be a prominent exception, as was shown in Section 6.

9. Conclusion and perspectives

9.1. When is PES the preferable conservation instrument?

> "Give a man a fish and he's set for supper. Teach him how to fish and he's set up for life."

This popular proverb expresses well the appeal of ICDPs and other indirect approaches: removing the obstacles to sustainable development (poverty, shortages of capital, technology and skills) would 'fix the problem' and make people embark on pro-conservation paths — in principle, forever. This message about the alleged synergy between development and environment from Brundtland and Rio 1992 was politically attractive, but unfortunately, in the conservation field, the flaws in the 'teaching-to-fish' strategy are increasingly apparent.

ICDPs attract two main criticisms. First, although you have taught the man to fish, he might still have enough time and resources to extract logs, shoot game, and clear forests — nothing *per se* obliges him to change his approach. Secondly, what does it take to teach the man to fish? If it takes one strategy paper, two village-development plans, three participatory workshops, four action researchers, a fish-processing plant and an army of project staff and consultants… it might just be cheaper to buy the man a fish every day. This is precisely the justification for PES — the promise of more efficiency from giving the man a fish as a direct reward, *if and only if* he conserves.

Notwithstanding the attractiveness of PES directness, various caveats remain. First, as an ES buyer you need a sustainable source of PES financing, often into infinity. Further, while demand may remain restricted, supply-driven expansion of environmental services is unrealistic. From the provider side, any random upland community cannot just decide in a village meeting: "What are we going into this year, folks — watershed protection, biodiversity or landscape beauty"? Except for the geographically mobile carbon services, the spatially specific ES character will imply that the buyers or intermediaries will usually take the initiative, approaching providers because they realize the latter control a strategic and increasingly scarce environmental asset.

Second, one has to build the initial trust or "social capital" for PES. The man out there in the wilderness may believe when you offer him fish that you in fact want his land, or some other PES-camouflaged fishy business. Building that trust, and setting up the rules, monitoring and rewards, may be cumbersome, take time and require an 'honest broker' like an NGO as intermediary — yet success is still not guaranteed. Indeed, communities may not accept a *quid pro quo* agreement when they are accustomed to multiple donors and agencies offering benefits for free. Decades of paternalistic rural development projects may thus create expectations that are hard for innovative initiatives to break, even if both sides might be better off.

After all, PES can thus also involve high transaction costs. Certainly, there will be cases where outright land purchases are a more rational conservation strategy than the PES approach of buying time-bound land-use rights. In other scenarios, command-and-control will remain preferable to economic incentives. In yet other contexts, the ICDPs remain a better approach, since a 'win-win' switch to more sustainable *and simultaneously* profitable private production can actually be achieved through point-wise interventions — indeed an attractive option to the buyer, who would not need to go on paying forever. Perhaps a new generation of 'contingent ICDPs' will emerge. PES-ICDP hybrids could be short-run payments rewarding technological adoption, such as in the RISEMP project where ranchers receive conditional payments for two to four years, combined with technical assistance, in order to achieve lasting shifts from treeless to silvo-pastures (Pagiola et al. 2004). In other words, many non-PES approaches will also remain highly relevant, perhaps in new, more direct forms.

Conservation practitioners often feel irresistibly attracted to high-threat scenarios, where intervention seems most badly needed. Is this also where PES should preferably be used? Certainly PES makes sense only when there is some current or projected threat; without threat there is no additionality and no *raison d'être* for PES. But if high threat means high opportunity costs, PES will usually not be the answer. Often there will simply not be enough funding available; in PES terms, it is best to 'let go' these scenarios, and possibly apply other tools. Conversely, if the desired land use is already privately more profitable than the non-desired one, it normally makes no sense to apply PES. PES is thus most useful in the *intermediate* range of positive but numerically small opportunity costs: degraded pastures, marginal croplands, forests in slow-moving agricultural frontiers, etc. Like other economic incentives, PES makes the most sense at the margin of profitability, when small payments to landowners can tip the balance in favor of a desired land use. It was also hypothesized that scenarios with *projected* threats could be ripe for PES as a form of environmental insurance.

9.2. How to design a PES scheme?

If one has chosen to go the PES route, what hints can one give about desirable PES design? Apart from a few exceptions (Costa Rican PES, some carbon projects), most tropical PES initiatives are incipient, so assessing their conservation and livelihoods impacts remains somewhat premature. Conceptually, it is wise to distinguish between 'true PES' and the much broader family of 'PES-like' initiatives. The former are few, the latter many — and converting some of the latter into the former would seem desirable in order to seriously try out the PES principles, especially conditionality. Area- vs. product-based PES, and state-run vs. private schemes, also infer some design differences. Use-restricting vs. asset-building schemes have different impacts on rural activity levels.

A baseline is essential for ES buyers to plan and later assess PES additionality, otherwise funding can be wasted paying for things that would have happened anyway. Some idea about ES providers' conservation or restoration opportunity costs can be very helpful in this respect — often more helpful than hard-fought attempts to undertake full economic valuation of the ES flows proper. To reward basically anybody who 'delivers an ES', based on a politically attractive fairness principle (Rosa, Kandel, and Dimas 2003; van Noordwijk, Chandler, and Tomich 2004; Gutman 2003), seems unwise. First, current funding levels would fall far short of the money required for indiscriminate payments. The Costa Rican PES, with enrolment applications exceeding available funding by about factor of three, is illustrative (Rojas and Aylward 2003).

Second, being a so-called 'ES provider' often just means *not being* an environmental vandal. Across-the-board entitlements could endorse blackmail by anybody owning a non-threatened asset, from Scandinavian forest owners threatening to cut down their trees to receive carbon payments, to remote indigenous people threatening to deliberately pollute a river to receive watershed payments from downstream users. It is crucial that the underlying 'victim pays principle' in PES should not be taken to such absurd extremes. On the contrary, payments need to be applied strategically in those cases where additionality can clearly be demonstrated. Only in this manner can users' willingness to pay over time be broadly enhanced. Yet this also means that people already living in approximate harmony with Nature, without any credible reason to endanger ES, nor any external threat, will generally not qualify as PES recipients.

If noble savages, nature lovers and farmers involuntarily being environmentally benign are not the prime targets of PES, then who should be paid? One should pay a critical mass of agents that both bear some current or projected conservation opportunity costs and have credible, site-specific claims. A timber company would qualify only if it has a concession and profits from it. A land squatter would require informal but widely respected and enforced claims on the land, and the prospect of privately benefiting from its extensive exploitation. ES buyers should not necessarily refrain from contracts with informal tenants as long as they can demonstrably deny access to third parties. Buyers may also use 'carrots' on top of existing legal 'paper sticks' that have proved ineffective, unless this glaringly leads to perverse incentives. These targeting options will be superior in private, localized PES schemes, as opposed to the state-run PES systems where flexibility and additionality will typically be lower.

Payment modes should be negotiated in advance with PES recipients, leading to a choice of cash, in-kind or technical assistance — or customized combinations of these. *De facto* irreversible benefits, like tenure-security provision, may eventually be a precondition for PES establishment, but they would not be effective incentives providing ES. Likewise, schemes biased towards large up-front benefits, whether cash or in-kind, are not compatible with long-run, continuous service provision, and should generally be avoided. The choice of payment modes should consider whether the opportunity costs are in cash or forgone in-kind benefits. Mimicking regular income flows with small but frequent payments will often be socio-economically rational.

Will PES become a motor for poverty alleviation? The existing comparative assessments (Landell-Mills and Porras 2002; Rosa et al. 2003; Pagiola et al. 2005; Grieg-Gran et al. 2005) seem to conclude that:

- net positive effects for ES sellers are likely. Gains include non-income benefits, often in particular for moderately poor smallholders;
- some access rules and structural constraints hamper participation by the poor, while others are in their favor;
- PES has mixed effects on impoverished non-sellers, but the landless poor engaged in environmentally degrading activities could lose out significantly;
- the small scale of PES application generally also constraints poverty alleviation.

Perhaps the main take-home lesson is that if PES does not deliver the service, buyers will not continue to support it, and thus PES will also not benefit the poor. Well-meant targeting efforts should be careful not to jeopardize the basic functionality of PES. Poverty alleviation is an important side objective, which can be pursued through timely interventions (targeting, transaction-cost reduction, pro-poor premiums and subsidies), but it should never become the *primary* objective. If we impose a lot of side objectives on PES (poverty alleviation, gender, indigenous people, human rights, and other noble causes), PES would become the new toy of donors, NGOs, and government agencies. At the same time, the outreach to the private sector would be much more limited, thus losing new financing options. Eventually, PES would become 'old wine in new bottles', subsumed into the generic family of altruistic development projects to which they were actually meant to be an alternative.

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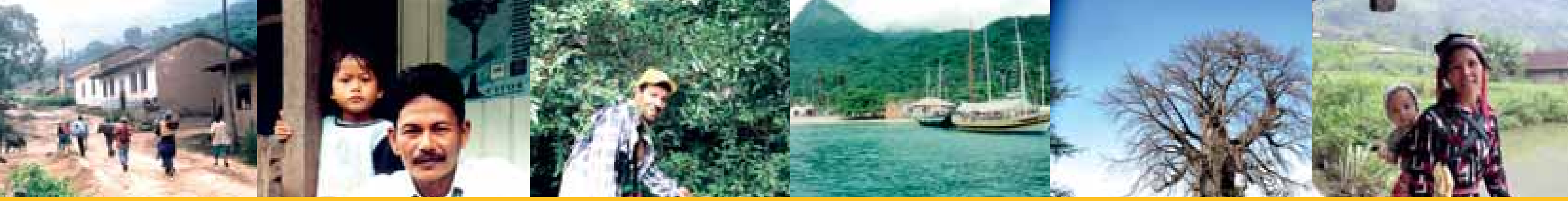

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ACTION PLAN FOR RESTORATION AT AMBOHILERO FOREST, MADAGASCAR, AND SIMILAR AREAS OF DEGRADATION

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Aug. 30, 2007

ACTION PLAN FOR RESTORATION AT AMBOHILERO FOREST, MADAGASCAR, AND SIMILAR AREAS OF DEGRADATION

Aug. 30, 2007

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Success would not have been possible without the exhaustive participation of every member of the team. During the expedition, the team divided into three working groups, listed below. The first group was responsible for collecting data with respect to Objective 1, the second with Objectives 1-3, and the third with Objective 4.

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I. INTRODUCTION

In November 2004, President Marc Ravolomanana discovered a logging road built by the Malaysian-owned Latitude Timber Co. This road construction and associated timber exploitation are in the Forestieres de Veriantsy et de Sahananto a l' interieur de la foret classee d'Ambohilero, Fkt Amboarabe, C/R de Didy. The main area of exploitation and road construction begins about 3.5 km southeast of Antsevabe within the primary evergreen forest of the Ankeniheny-Zahamena corridor region (Figure 1). According to local leaders, Latitude Timber began road construction and timber harvesting in April 2004, and all activities were stopped in November 2004 by order of the president. During these eight months of exploitation, Latitude Timber used heavy machinery to widen some existing logging roads from less than 3 m to greater than 10m in most places, to construct large areas of new road, and to harvest timber by clear-cutting along the edges of the newly constructed roads (Figure 2, see Karpanty et al. 2005 for details of the exploitation).

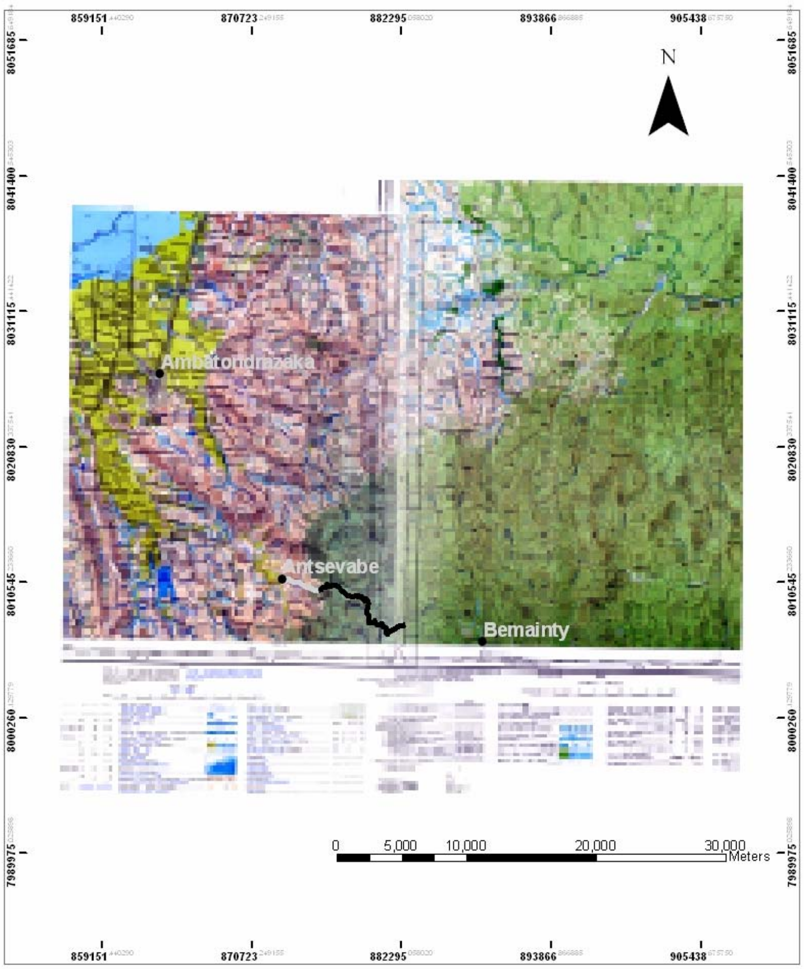

Figure 1: Main area of road construction and timber exploitation (black line), area of road widened between Antsevabe and the start of timber exploitation (gray area), and the region's major cities and villages.

Figure 2: Main road construction and timber exploitation as seen from a view above the Latitude Timber camp in 2005 looking towards Antsevabe.

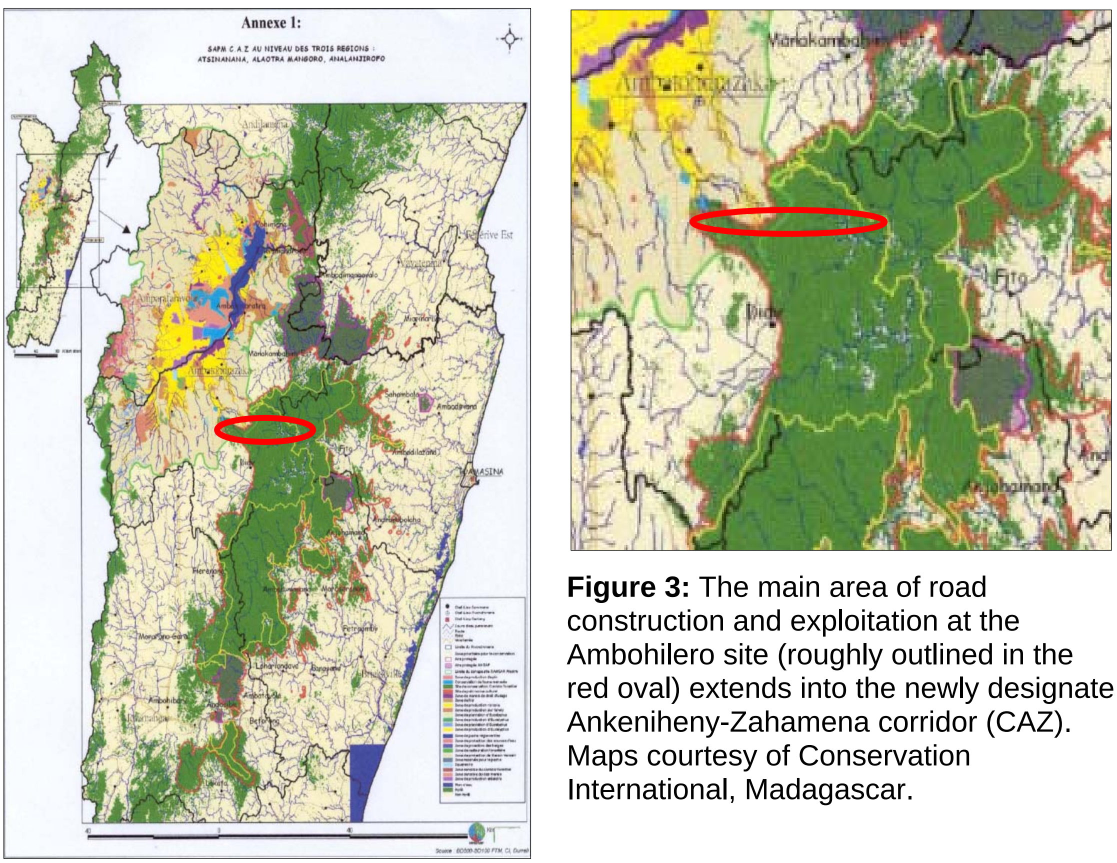

Figure 3: The main area of road construction and exploitation at the Ambohilero site (roughly outlined in the red oval) extends into the newly designate Ankeniheny-Zahamena corridor (CAZ). Maps courtesy of Conservation International, Madagascar.

Deforestation such as that caused by these logging-related activities threatens biodiversity, watershed integrity, soil productivity, and the associated economic value of the land for local people. It is broadly accepted that the regrowth of forests removed from key areas such as this one will be necessary to make the Durban vision a reality. While the goal of regrowing forest stands is shared by many, the techniques for doing so are minimally developed in Madagascar. Many scientists feel that tropical deforested areas are unlikely to regenerate to pre-disturbance ecological or economic quality without active reforestation. However, much remains to be learned about regrowth in tropical forests. It would be a welcome surprise to discover that tropical moist forests have some capacity for self-regeneration. The road in Ambohilero Forest (sometimes called Didy Forest), while an unfortunate incursion into pristine forest in a new protected area under Durban vision activities (Figure 3), provides an opportunity to study rainforest regeneration and to compare natural regeneration capabilities with regeneration through active restoration over the long term.

In this report, we summarize activities at this site since logging activities stopped in 2004, conduct an assessment of natural regeneration at the site since then, and develop an action plan for consideration by USAID's MIARO program. USAID/Madagascar is currently supporting restoration and reforestation activities through its MIARO, ERI, and JARIALA programs. These efforts aim to complement the move to expand Madagascar's protected area network from 1.7 million hectares to 6 million hectares by 2012. Reforestation of degraded landscapes is one component of this large plan to expand protected areas.

The aim is that the technical assistance described in this report will complement ongoing USAID activities along the eastern escarpment of the country. Specifically, they should allow us to learn the potential costs and benefits associated with active restoration versus natural regeneration in the humid forest. Also, they should serve as a much-needed catalyst for reflecting on and improving restoration techniques across Madagascar.

The team described in this report was invited to provide technical assistance to assess the situation and develop the action plan. USAID MIARO will provide $10,000 for implementation of the action plan.

Actions from the cessation of logging activity to May 2007

In June 2005, the Malagasy government asked for the assistance of USAID/Madagascar in quantifying damage to the previously undisturbed Ambohilero Forest corridor by the logging operations. They also sought advice on the feasibility of an ecological restoration of the disturbed area.

In July 2005, the first expedition to the region (Karpanty et al., 2005), supported by USAID's MIARO program, quantified that 51.81 hectares of forest had been directly exploited during the logging operations and 184 to 600 additional hectares were indirectly affected by secondary impact such as soil erosion, altered water dynamics, introduction of non-native species, and effects on biodiversity.

In an out-of-court settlement in 2005, Latitude Timber was tasked with planting 21,000 native tree species in areas of forest affected by its logging operations. While the settlement was at least a step in the right direction, the requirement was significantly less than the minimum scenario of 56,000 trees recommended by Karpanty et al. after the 2005 planning expedition.

Another team of specialists collaborating with national experts visited the affected area from Sept. 25 to Oct. 2, 2005, to assess the level of damage and to evaluate prospects for restoration (Aronson et al., 2005). The most severe impact was observed along an 11 km portion of the logging road where Latitude Timber carried out intensive exploitation and established numerous secondary tracks into the surrounding forest. Damage was less severe along a 6 km stretch of road extending farther into the forest. The road had been established in the 1990s by a Malagasy logging company following a footpath that dates from at least the 1950s; it was later widened by Latitude Timber, but adjacent forest was not harvested.

In March and November 2006, a MIARO team visited the site to assess progress related to the recommendations from the September 2005 expedition. By this time, a tree farm with some of the required 21,000 native seedlings had been established, and reportedly 7,000 of these had been planted in high-priority areas in the disturbed region. The MIARO team trained the Latitude Timber consultant firm, Avotr'Ala, in additional stabilization and anti-erosion techniques as recommended by the September 2005 team, and erosion control structures were established in many areas.

Despite these activities by a diversity of stakeholders, several questions remained regarding restoration and the best way to proceed, given the limited resources: The extent of natural revegetation? Where and how to plant the remaining seedlings started by Avotr'Ala? What species of additional seedlings are needed? How to maximize natural regeneration occurring in the least disturbed areas? Where to focus erosion control activities? The purpose of the May 2007 expedition detailed in this report was to bring together existing and new experts to answer some of these questions and to design a plan for MIARO's activities at the site through September 2008. Specific expedition and report objectives follow.

Objectives

- To assess passive restoration since the last site visit by this team in July 2005 and the cessation of logging activities in November 2004.
- To assess the health of planted and nursery tree seedlings, and to develop recommendations for planting the remaining seedlings to best provide habitat and movement corridors for key wildlife species.
- To evaluate the successes and limitations of restoration activities by MIARO and Avotr'Ala, and to recommend additional practices as needed.
- To assess the socioeconomic impact of the road on Bemainty and Antsevabe, the two villages at opposite ends of the logging road.

II. OBJECTIVE 1: METHODS, RESULTS, GENERAL RECOMMENDATIONS

- To assess the occurrence of passive restoration since the site visit by this team in July 2005 and the cessation of logging activities in November 2004.

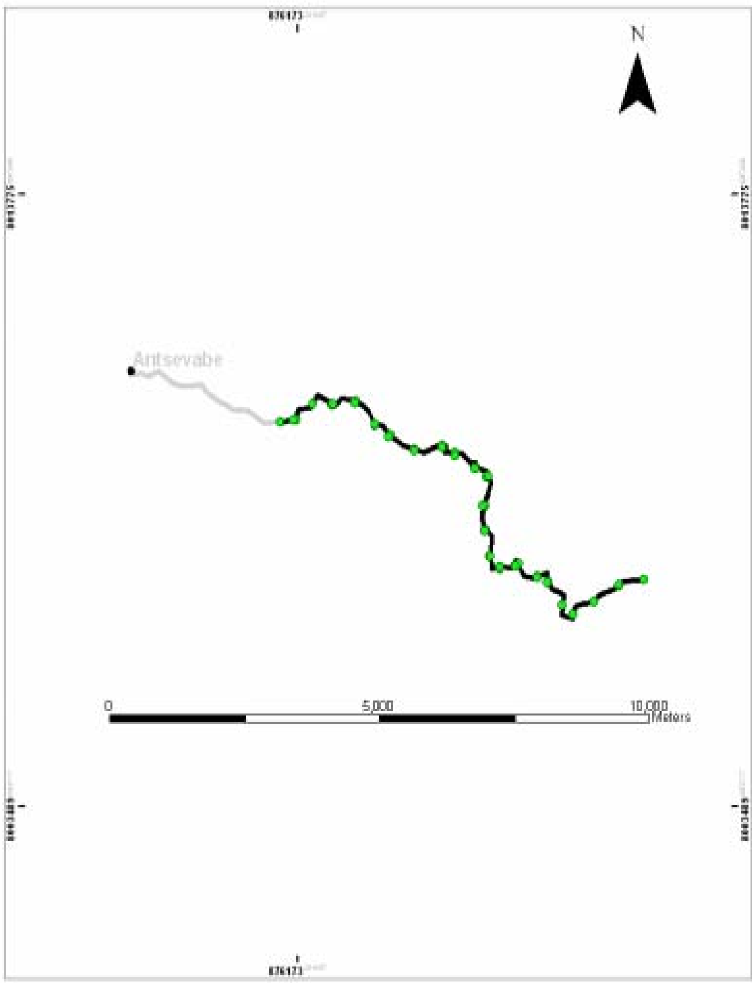

Figure 4: Location of 24 photo plots (green dots), each separated by 500 m, where digital photos were collected and road and clear-cut widths measured to quantify the area of direct damage.

Methods. To quantify natural regeneration, or passive restoration, we reexamined the 10 permanent botanical transects and 24 digital photo plots established along the logging road in 2005 (Figure 4). The GPS locations of the 10 botanical transects (each separated by 1 km) are in Appendix 1 and the photo plots (each separated by 500 m) in Appendix 2.

At each of the 24 photo plots, we took digital pictures in four directions from the center of the road (up toward Antsevabe, down toward Bemainty, to both sides) and measured the width of the road remaining, defined as the area of compacted or loose dirt created by Latitude Timber with no revegetation. A CD with the labeled photos from 2005 and 2007 was left with MIARO in Madagascar. Copies can be provided on request.

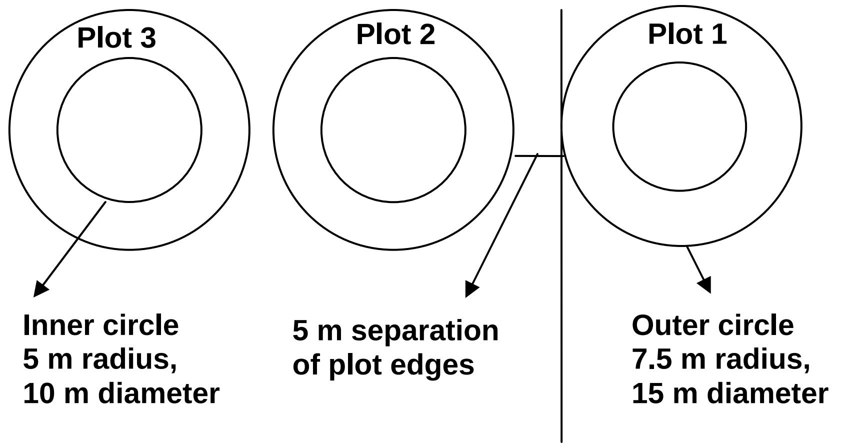

Figure 5: Layout of plots on each of 10 botanical transects. Each transect was evenly spaced along the main logging route and separated from adjacent transects by 1 km. Plot 1 of each transect is centered in the roadbed.

Figure 5 shows the design of the botanical transects, each involving three adjacent circular plots separated by 5m. The purpose of the inner, 5m radius plots was to accurately quantify density and diversity of herbaceous cover as well as trees less than 10 cm diameter at breast height (DBH). In these 5m radius plots, we recorded species identity and numbers of all plants less than 5 cm and between 5 to 10 cm DBH. We also estimated percentage of ground cover, leaf litter cover, and canopy cover at the center of each of these plots. The purpose of the larger 7.5m radius plots was to quantify density and diversity of large trees. In these larger circular plots, we recorded species identity and numbers of all trees greater than 10 cm DBH, and for each tree we recorded height, crown diameter, status (alive, dead, standing, fallen), the number of vines per tree, and an index of epiphyte abundance for each tree. These data are under analysis, and we plan to publish a comparison of the data between 2005 and 2007. These transect and photo plot data will be most valuable when comparatively analyzed over time. We recommend a biennial assessment of natural regeneration at this site to include replication of data collection from these same botanical transects and photo plots to increase our understanding of these processes in Madagascar.

Results. Karpanty et al. (2005) described three major restoration scenarios along the main 11.7 km primary area of exploitation. It was determined that there was great variation with respect to hydrology, soil compaction, and soil erosion depending on whether the site was on a primary, secondary, or tertiary road within the area of exploitation. In our reassessment of these sites in 2007, we did find that the level of passive restoration was greater on tertiary (Figure 6 a-b) and secondary roads (Figure 7 a-b) than along the primary exploitation route (Figures 8 and 9 a-b).

Compacted primary road plots (e.g., Figure 8 a-b) have changed little since 2005, while the sides of the primary road as well as the secondary and tertiary roads with lesser compaction have seen extremely rapid growth of pioneer species such as Harungana and Solanum despite the apparent absence of humus and topsoil. In many areas, we observed more than 3m of tree growth in the two years since our last observations. We are currently conducting analyses that will directly quantify the rapid growth rates of species in these plots over these two years, and we will publish that data when completed. We were surprised to find very few non-pioneer or primary forest tree species regenerating on the sides of the main road or on the secondary and tertiary roads. We need to monitor these plots over time to ensure that there will not be a recession of this area if pioneer tree species are not replaced by secondary succession trees.

We found that any natural mulch, whether zebu dung or organic plant material (Figure 10), greatly facilitated establishment and growth of tree species on the highly compacted main road. Given that large-scale plowing of the road to loosen the soil is unlikely (and not recommended due to the potential to increase erosion), we recommend encouraging natural mulching in as many areas as possible to facilitate passive restoration.

Finally, we found little change in the third plots on each transect, which are generally off the road exploitation area and inside the primary forest. This was encouraging, as it indicates minimal exploitation of the forest resources since the cessation of logging activities. We describe the use of the road for gold mining, quartz mining, and other non-sustainable activities in Section V of this report and maintain that commercial exploitation of this forest area remains the biggest potential inhibitor of its recovery and passive restoration.

Recommendations

- Conduct a biennial assessment of passive restoration at the Ambohilero site by reevaluating the botanical transects and photo plots. This will allow quantification of the process of passive restoration that will facilitate management of similar areas of degradation in Madagascar.

- Use our ongoing analyses of tree growth rates at this site to establish some parameters of passive restoration in Ambohilero forest and similar instances of degradation, e.g., upcoming nickel mining activities.

- Plant remaining forest tree seedlings in Ambohilero nurseries at selected sites (see Section VI of this report, recommended restoration sites) on the sides of the road underneath the existing regenerating Harungana and Solanum so that these pioneer species may provide shade for the primary and secondary forest tree plantings. It may be necessary to thin existing pioneer species trees on the sides of the road before planting.

- Encourage natural mulching, whether zebu dung or organic plant matter, along the primary road to facilitate seedling establishment and tree growth.

(a) **(b)**

Figure 6: Observed passive revegetation of secondary logging roads DS 14 **(a)** and DS 26 **(b)**.

(a) **(b)**

Figure 7: Change in vegetation due to passive revegetation along secondary logging road (photo plot DP2A) in 2005 **(a)** and 2007 **(b)**.

(a) (b)

Figure 8: Lack of revegetation along a highly compacted section of the primary exploitation route (photo plot DP17A) in 2005 **(a)** and 2007 **(b)**.

(a) (b)

Figure 9: Partial revegetation along a compacted section of the primary exploitation route (photo plot DP9A) in 2005 **(a)** and 2007 **(b)**.

Figure 10: Area with natural mulching (e.g., organic debris, zebu dung) showing enhanced tree establishment and growth along the primary road of exploitation.

III. OBJECTIVE 2: METHODS, RESULTS, GENERAL RECOMMENDATIONS

- To assess the health of planted and nursery trees and to develop recommendations for planting the remaining trees to best provide habitat and movement corridors for key wildlife species.

Methods. Our team surveyed the health of trees planted by Avotr'Ala at various sites along the Latitude Timber logging road, weeded and cleaned the two highly overgrown tree nurseries along the road (Figure 11), cataloged by species and estimated the number of viable trees remaining in the nurseries, and made recommendations about additional areas to plant the remaining tree seedlings.

Results. Our observations of the health of trees previously planted by Avotr'Ala are described in Section VI of this report, under the areas of intervention list. In general, we were surprised to find that relatively few trees were actually planted (estimated fewer than 500 trees) and, most alarmingly, that nearly all planted trees were still inside the plastic potting bags (Figure 11). The fact that Avotr'Ala did not remove the plastic potting bags when the plants were placed into the soil has greatly inhibited their growth and likely resulted in their eventual mortality. In most locations, we recommend that MIARO staff or contractors dig up the planted trees, un-bag them, then replant them so that they have a better chance of survival. Given that so few trees were planted, this task could be accomplished in a few days by a team of two individuals.

Figure 11: Trees planted by Avotr' Ala with plastic pots still encasing the seedlings.

We found the two nurseries established by Avotr'Ala to be overgrown and in need of weed removal but in better condition than expected (Figure 12). We cleaned the nurseries and removed dead seedlings (about 10% of plants were dead in the nurseries, an astoundingly low percentage considering the lack of care during the preceding months, suggesting that there could be a high survival rate when seedlings are actually planted). We found about 6,350 seedlings in good condition for planting by MIARO. Accounting for an estimated loss of 10% from within the nursery and having observed fewer than 500 planted seedlings, we could account for only

(a)

(b)

Figure 12: Tree nurseries established by Avotr' Ala before **(a)** and after weeding and elimination of dead seedlings **(b)**.

7,485 of the 21,000 seedlings that Latitude Timber had contractually agreed to grow and plant.

The following tree species remain in the two nurseries inside Ambohilero forest. We did not count exact numbers of each species but rather note the five most abundant species (** are the most abundant) here of the 6,350 seedlings remaining to be planted: **Cryptocarya, **Chrysophylum, **Allophylus, **Eugenia, **Abrahamia, Tambourissa, Dilobia, Tincitriata, Dalbergia, Blotia, Memecylon, Muscarensa, Bigea, Drypetes, Potamia, Erythroxylum. Our previous experiences with Malagasy rainforest reforestation suggest that all of the species above should have a fair chance of survival when planted at this site according to our recommendations below.

General recommendations for seedlings that remain in nursery and maintaining planted trees

- Plant remaining nursery trees along the edge of the road under fast-growing Harungana and Solanum, for there are no forest tree species in this zone, and the early succession species will protect the slower-growing forest seedlings. Separate the planted seedlings from the existing pioneer species by approximately 0.5-1 m.

- Transplant some of the existing Harungana and Solanum tree seedlings growing along the edge of the road into the area of the main road bed to facilitate corridor formation for wildlife and to simultaneously thin the sides of the road to increase success of planted seedlings. This will also lead to the creation of natural mulch in the compacted road zones and facilitate natural regeneration.

- Use tree and seedling planting guides developed by the Tetik'asa Manupody Saroka project (TAMS) to guide restoration activities.

- Plant in the 10 specific sites (R1-R10, Section VI) identified by the team. These sites were selected to maximize the potential for habitat connectivity and because of their relatively minimal slope they should be areas of minimal erosion.

- Do not plant or disturb the 10 botany transect areas so that passive restoration progress can be monitored over time (preferably every 2 years).

VI. OBJECTIVE 3: METHODS, RESULTS, GENERAL RECOMMENDATIONS

- To evaluate the successes and limitations of experimental techniques enacted by MIARO to control erosion and restore soil fertility, and to recommend additional practices as needed.

Methods. We surveyed the entire length of the primary, secondary, and tertiary routes of Latitude Timber exploitation to develop a realistic evaluation of erosion control needs. We recognized that there are very limited financial resources for active restoration work at this site, so we did not include mechanical techniques such as tillage or labor-intensive restoration techniques such as construction of structural sediment dams in our suggestions. We limited our recommendations to:

- Areas where erosion is directly affecting a water source (see Section VI of this report).
- Areas of planned tree restoration (see Section VI of this report).
- Existing areas of erosion control constructed by MIARO and partners (see Section VI of this report).

Results. In general, we do not recommend any activities to stabilize the road areas constructed by Latitude Timber unless they are negatively affecting a water source. We believe that keeping human exploitation of this forest to a minimum will be the most effective way to facilitate passive restoration and that allowing the road to erode naturally and to become more impassable will assist in reducing human impact. Where erosion is directly affecting a water source or threatening an area of tree plantings, we recommend the inclusion of water bars (Figure 13 a-c) and the encouragement of natural vegetation (e.g., rangaza, Figure 14 a-b) to control hillside and gully erosion. Methods for constructing water bars are provided in Appendix 3. Several Malagasy team members were trained in techniques of water bar placement and construction during this expedition, specifically Andrianamatody of Antsevabe and Eugene Boto, Collaborateur CIREEF, from Ambatondrazaka.

We were surprised to find that a plant identified as rangaza, a bunch type of grass, provided the best observed technique for erosion control (Figure 15). We have not yet determined the plant's scientific name, and we recommend that future expeditions collect proper specimens for formal identification. We recommend using rangaza to control gully growth and to fortify unstable slopes. Rangaza can be transplanted into gullies to form a living grade stabilization structure. It is naturally revegetating and stabilizing some steep slopes, a process that could be accelerated with transplanting. Rangaza appears to be quite hardy and able to grow in the most highly erosive situations. However, it did not appear to grow in highly compacted areas. Large bunches of rangaza divide easily into sprigs that can be planted where needed. Our team has not observed this plant in other regions of Madagascar, but all local guides and assistants believe it to be native to Madagascar. The identification of rangaza is a priority.

General recommendations

Our recommendations for the placement of water bars and other erosion control techniques are described in Section VI. Whenever possible, we recommend mulching actively eroding areas with zebu manure and other organic debris to protected planted seedlings. We also recommend that, except on the steepest slopes, the seedling bags on trees planted by Avotr' Ala be removed and the trees be replanted.

(a) (b) (c)

Figure 13: Demonstration water bars in areas of high soil erosion affecting important water sources or threatening tree planting. **(a)** Depth of 25 to 35 cm), **(b)** placement across the road to intercept gully and concentrated flow, and **(c)** construction.

(a) **(b)**

Figure 14: Natural rangaza growth. Site in 2005 **(a)**, and the same site largely stabilized in 2007 with rangaza **(b)**.

(a)

(b)

Figure 15: Natural rangaza establishment and erosion control in a gully **(a)**. Rangaza sprigs for replanting **(b)**.

V. OBJECTIVE 4: METHODS, RESULTS, GENERAL RECOMMENDATIONS

- To assess the socioeconomic impact of the road on Bemainty and Antsevabe, villages at opposite ends of the logging road.

Methods. We conducted interviews separately with men and women from 10 households each in the villages of Antsevabe and Bemainty, which are at opposite ends of the area of exploitation (Figure 1). Antsevabe (S 17° 57.533′, E 48° 31.214′) is divided into three sections (Antsevabe center, Tanambao, and Andakazera) with about 3,089 inhabitants, most of the ethnic origin Sihanaka (Figure 16). Bemainty (S 17° 58.286′, E 48° 34.899′) is about 40 km by logging road and narrow trail from Antsevabe. It is divided into five sections. Sahananto and Sahambato are 9 km and 13 km, respectively, from the center of Bemainty (Sahavolosy); Ambodihazomena and Maromanagana are each about 1 km east of Bemainty center. In total, there are about 200 household in these five sections of Bemainty, and most individuals are ethnically Betsimisaraka (Figure 17).

Figure 16: The village of Antsevabe, about 25 km southeast of Ambatondrazaka.

Our questions were designed to explore comments made by Antsevabe villagers in 2005 relating to the potential water-quality impact of the road construction, their loss of 8,000 planted Eucalyptus trees during the construction phase, and general impressions of the road and its effect on their daily lives. With men and women in each household interviewed separately, we discussed the following topics: 1) basic demographic information and origins; 2) values and uses of forest and region of road before and after Latitude Timber expansion; 3) land-use practices in the past, present, and future; 4) perceived effects and attitudes toward road construction; and 5) familiarity with the new protected-area plan and community-level forest association (COBA). Summary responses to these questions are in Table 1. Full responses by families and individuals can be provided on request.

Results. The two villages differed in their general impressions of the benefits and costs of the Latitude Timber exploitation. All households in Bemainty viewed the road construction

Figure 17: The village of Bemainty, about 40 km from Antsevabe.

and exploitation as positive, with many householders saying they wished the major road widening had continued all the way to their village and that the road would be maintained for motorized vehicle passage. The main advantage of the road, cited by households in both villages, is increased travel ease to bring products to local markets and to visit relatives in more distant locations. In general, Antsevabe villagers were better educated, likely given their closer proximity to the city of Ambatondrazaka, and expressed more negative views of the road construction. Several households in Antsevabe stated that sedimentation in rice paddies had increased since road expansion and forest exploitation; however, we could not confirm these claims. In actuality, the Sahananto River, the main water source directly impacted by the Latitude Timber Co., drains eastward toward Bemainty. Villagers in Bemainty did not report any perceived downstream effects of increased erosion rates in the forest; however, unless some steep road banks next to the river in the area of the Latitude Base Camp are stabilized (see E1 in Section VI), sedimentation rates could increase in the future.

Common points made by villagers at both ends of the road include concern about a lack of area for new tavy – a term used in Madagascar for slash-and-burn land-clearing techniques – to support a growing population; and about increased climate variability and unpredictable growing seasons. Most households in Antsevabe and Bemainty are involved in the Anjarasoa COBA. They are aware of the movement toward new areas of protection in the region and are concerned about how these new classifications will affect their ability to create tavy and their access to timber and non-timber forest resources.

Households in both villages expressed concern over increased use of the forest by outsiders (e.g., individuals from Antananarivo and Ambatondrazaka) since the Latitude Timber exploitation. We suggest that this is perhaps the most dangerous indirect impact of this road activity and should be closely monitored and regulated.

During our expedition, we saw a small gold-mining operation, led by individuals from Antananarivo, double from about five workers to more than 10 in just under six days, expanding its footprint in the Ambohilero classified forest (Figure 18 a-c). Because our team was actively working in the forest, we were able to notify the local forestry official (Chef Triage des Eaux et

Foret) in Antsevabe, who ordered the miners to leave within two days. We are not sure of the outcome of that mandate and suggest that it should be followed up and that the chef triage should be adequately supported so that he/she can be a front line of defense against further illegal mineral exploitation. The chef triage himself and his office in Antsevabe are both important additions since the 2005 mission.

We recommend the following actions relating to socioeconomic impact of the Latitude Timber exploitation:

- Involve COBA Anjarasoa in environmental education so that local populations can learn and appreciate the multiple-use values of the forests surrounding their villages. Interviewees did not express any known values of a forest ecosystem other than products to be harvested and did not discuss benefits such as clean water. Many villagers still hunt lemurs, and, while they expressed concern over declining numbers of the lemurs available to be hunted, they did not make any connection that the decrease may be related to over-hunting.

- Continue to fully support the presence of the chef triage in Antsevabe. If possible, increase his/her powers to enforce restricted uses of the classified forests and to limit incursions into the area by outsiders.

- If the road is maintained, then increased exploitation is likely by locals and outsiders.

Figure 18: Gold miners from Antananarivo in Ambohilero classified forest in May 2007.

Table 1: Summary of responses, May 2007, of villagers from 10 households in Antsevabe and 10 households in Bemainty to questions regarding Latitude Timber exploitation of Ambohilero Forest.

Data/Question	Antsevabe	Bemainty
No. Women Interviewed	5	6
No. Men Interviewed	6	9
Mean Age Women (range)	44 yrs (36 – 50 yrs)	38 yrs (27 – 50 yrs)
Mean Age Men (range)	57 yrs (39 – 81 yrs)	50 yrs (27 – 70 yrs)
Participation in COBA	9/10 families participate in COBA Anjarasoa	9/10 families participate in COBA Anjarasoa
Mean No. Children (range)	3.5 children/household (2 – 6 children/ household)	6.1 children/household (0 – 15 children/household)
Do children attend school?	9/10 families send children to school	7/9 families send children to school
What are activities that contribute to your livelihood?	All conduct farm-level agriculture, primarily tavy, raise chickens and cattle, one household collects and sells quartz	All conduct farm-level agriculture, primarily tavy but some valley rice cultivation
What are the activities of your adult children that contribute to their livelihood?	Same as parents, limited by the amount of land as new tavy areas are limited because of new protected area classifications. Children inherit land from parents.	Same as parents but limited by the amount of land, as they must leave their parents' land and find new areas.
Are there advantages or disadvantages to the Latitude Timber road?	6/10 families view the road construction as a positive event, as it increases ability to visit more remote villages. 4/10 families cited increased erosion and sedimentation as reasons why the road construction was a negative event.	8/10 families view the construction of the road as a positive event, primarily because it enables easier delivery of products to local markets. The 2/10 families that disagree say that only because the road is not in good enough condition for automobile travel.
Are there differences in the way that you use the forest from before the road construction?	Uses of forest have not changed except there is increased use of the road for travel. 3/10 families use the forest to hunt lemurs.	Uses of forest have not changed except there is increased use of the road for travel. 5/10 families use forest to hunt lemurs.
Are you interested in reforestation?	9/10 households are interested in reforestation but need education on techniques. 1 household is not because they feel areas to construct new tavy are already limited.	10/10 households are interested in the idea of reforestation but need education on techniques

VI. LOCATION-SPECIFIC ACTION PLAN FOR TREE PLANTING, EROSION CONTROL

Site ID explanations: "A" code refers to areas of intervention by MIARO and Avotr' Ala before this expedition. "E" code refers to areas where we recommend one or several erosion control techniques. "R" code refers to areas where we suggest active tree planting or active restoration. "W" code refers to areas where we specifically recommend construction of water bars.

Site ID	GPS S	GPS E	Recommendation	
A1	17°59'12.5"	48°35'05.5"	Intervention on slope up to old Malagasy logging road. Some natural regeneration in zebu dung and 18 planted trees are doing okay. We recommend un-bagging the trees and reinforcing existing barrages with rangaza as a naturally regenerating barrier to erosion.	
A2/R7	17°59'04.3"	48°35'05.2"	Tree plantings are doing well on this secondary road. Recommended reforestation site R3. It is a good area for additional plantings, but water bars should be added about every 20 m in the steeply sloping portion of the road adjacent to the main road. Encourage ground cover such as vines and rangaza to stabilize the slope.	

Site ID	GPS S	GPS E	Recommendation	
A3	17°57'45.5"	48°33'36.3"	Three existing barrages in gullies. It is not necessary to maintain this intervention, as it is only serving to stabilize the road, which is not desired.	
A4	17°58'40.1"	48°35'02.2"	Two of three tree plantings are still alive. Not an area in need of erosion control. We buried bamboo shoots here to determine if they might take root and naturally stabilize the soil.	

Site ID	GPS S	GPS E	Recommendation	
A5	17°57’57.3”	48°33’49.9”	Only 3 of 7 planted trees are still alive. 100 m uphill from A4. Good area of intervention, but here and in other places, we recommend using rangaza as a natural self-sustaining barrage other than the structural barrages shown here.	
A6/R8	17°57’59.2”	48°33’56.3”	A6 is a steep slope partially colonized by rangaza with trees planted. Recommend removing bags from these trees and replanting. Recommended reforestation site R9. Large trees are closing in on either side of the road (a peak and saddle area), so this is a priority area recommended for tree planting to reestablish a tree canopy across the road. Should also place several water bars upslope of planted trees to be planted to protect the seedlings from erosion.	

Site ID	GPS S	GPS E	Recommendation	
A7/R9	17°58'01.6"	48°34'00.2"	Steep slope with natural rangaza and planted trees. Also, long barrage along road with 10 smaller barrages and soil grafts. No trees are growing in soil grafts. We recommend monitoring the grafts, but they do not seem to be useful. This slope is steep, so we do not recommend disturbing it to un-bag trees for worker safety reasons. Rangaza is in the process of revegetating the slope. Recommended reforestation site R10. We recommend transplanting Harungana and Seva into the road bed, planting nursery trees under Harungana and Seva canopy on sides of road.	
A8	17°58'09.4"	48°34'06.5"	Two additional landslide areas upslope from E10 partially revegetated with rangaza and planted trees. Should not disturb slope, may want to encourage natural vines at top of slope. Also have 10 soil grafts and tree plantings at top of hill, should un-bag and replant these trees.	

Site ID	GPS S	GPS E	Recommendation	
A9/R10	17°58'11.5"	48°34'14.7"	Site has 15 circular soil grafts on both sides of the road, 0.5m in diameter each. Some herbaceous vegetation is growing in grafts but not yet spreading. Recommend monitoring this site but not expanding. Recommended reforestation site R12 is at this location. Recommended reforestation site due to low slope and narrow gap in existing canopy of large trees on both sides of the road.	
A10	17°58'12.4"	48°34'18.0"	Area with planted tree seedlings. Should remove tree bags, replant, and allow rangaza to spread. Not a priority for more planting because of wide gap in existing tree canopy.	

Site ID	GPS S	GPS E	Recommendation	
A11	17°58’13.1”	48°34’26.0”	Recommend adding a water bar as shown and un-bagging and replanting seedlings in area.	No photo available
A12	17°58’09.4”	48°34’32.2”	Series of our barrages in a gully. Continue to maintain by reinforcing with rangaza. These four barrages reportedly took four hours for two people to construct. Rangaza equivalents could be constructed in one-fourth the time.	

Site ID	GPS S	GPS E	Recommendation	
A13	17°58’08.9”	48°34’35.1”	Two rows of soil grafts with transplants. Not yet spreading, tree ‘volunteers’ in some grafts. Recommend monitoring soil grafts. Barrage runs up and down slope and is not effective for erosion control. No need to maintain.	
A14	17°58’12.4”	48°34’38.4”	Several barrages working well here. Could reinforce with rangaza, but not a high priority restoration site.	

Site ID	GPS S	GPS E	Recommendation	
A15	17°58’11.3”	48°34’41.8”	7-10 soil grafts. Little evidence of regeneration from soil grafts. Continue monitoring.	
A16	17°58’19.4”	48°34’59.2”	Healthiest area of tree planting observed, with 7 of 9 trees planted behind barrages, still living. Seedlings should be un-bagged and replanted. Heavy gully formation on the left side of the road. We recommend stabilizing gullies with rangaza to protect tree seedlings. The soil grafts at this site are also doing well, with young trees growing many. Continue to monitor.	

Areas proposed for active erosion control (E1-8)

Site ID	GPS S	GPS E	Recommendation	
E1	17°59'20.1"	48°35'43.1"	High priority area for active erosion control activities because unstable slope is adjacent to river and there is little buffer between the slope and river. Demonstration water bars were constructed here, on roadway down to Malaysian timber camp. There is no way to control the major landslide next to Sahananto River, but erosion from this slope can be limited with water bars every 20m to direct water away from the slope and disperse in what buffer areas exist. Rangaza should also be planted near the top of the steep slopes with the expectation that it will spread down slope by windborne seed dispersal.	
E2	17°59'18.2"	48°35'41.6"	High priority area for active erosion control on roadway and steeply sloping side fill. Place water bars in road upslope between E3 and E2. Revegetate slope with rangaza. This landslide has partially dammed a small stream, creating a pond.	

Site ID	GPS S	GPS E	Recommendation	
E3	17°59'18.4"	48°35'40.1"	E2 and E3 are less than 100 m apart. We recommend placing a water bar midway between E3 and E2, and encouraging natural vines to grow as shown here at E3. Loose ends of vines should be carefully pulled from areas adjacent to the roadway and anchored with soil.	
E4	17°59'20.3"	48°35'31.7"	Landslide has partially blocked the road, and revegetation is creating a natural corridor for wildlife. We recommend mulching areas without vegetation to encourage regrowth.	

Site ID	GPS S	GPS E	Recommendation	
E5	17°59'18.5"	48°35'25.8"	Landslide area but now approaching natural stable slope, so no need for large-scale intervention. Recommend planting rangaza and encouraging vines on slope.	

Site ID	GPS S	GPS E	Recommendation	
E6	17°58'49.1"	48°34'59.9"	There is a high wall here as a result of excavation to reduce the road slope. We recommend planting Seva and Harungana seedlings from nearby areas on top of this wall and wherever else feasible, and vines down the sides.	
E7	17°58'09.4"	48°34'05.5"	New landslide post-cyclone 2007. Recommend planting rangaza and natives vines on slope to stabilize.	
E8	17°58'09.5"	48°34'10.4"	Loose soil due to recent landslides with little revegetation. Plant rangaza and native vines.	No photo available

Areas proposed for active reforestation with trees from the existing nurseries (R1- R6 here, R7- R10 in A section above). We recommend planting nursery-grown primary and secondary forest trees under the cover of fast-growing pioneer species (e.g. Harungana and Solanum) along the sides of the road. We also recommend moving some of the existing pioneer species from the road sides into the center of the road to facilitate corridor formation and create natural mulch on the compacted road bed.

Site ID	GPS S	GPS E	Recommendation	
R1	17°58'24.0"	48°35'02.4"	Good saddle area for tree planting to create a corridor. We recommend placing water bars every 20m to facilitate tree growth.	

Site ID	GPS S	GPS E	Recommendation	
R2	17°59'15.2"	48°35'18.2"	Natural corridor starting to form in a relatively flat area, so good for targeted tree planting. We recommend mulching and additional tree planting.	
R3	17°58'56.7"	48°35'03.6"	Recommended spot for active corridor restoration, as there are large trees on both sides of the road. Plant combination of forest trees, Seva and Harungana.	

Site ID	GPS S	GPS E	Recommendation	
R4	17°57’45.5”	48°33’36.3”	Recommended site for active reforestation to restore wildlife corridor. Currently there is a 7m wide gap in the canopy, with large trees on both sides of the road. Top of saddle. Located between DP21-20	No photo available
R5	17°58’09.8”	48°34’07.4”	Recommended site for active reforestation to restore wildlife corridor. Currently there is a 7 m wide gap in the canopy, with large trees on both sides of the road.	No photo available
R6	17°59’15.7”	48°35’06.4”	Recommend tree plantings and mulching at this site to assist in closure of a natural corridor, which is less than 1 m wide.	

Recommended sites for water bars: In addition to using water bars along with active tree planting as described in R 1-10, there were two additional sites where we recommend water bars.

Site ID	GPS S	GPS E	Recommendation	
W1	17°59'19.8"	48°35'39.2"	Recommend installing a water bar angled so that it crosses just upslope from a pile of logs just off the bottom right corner of this photo.	
W2	17°57'59.6"	48°33'52.6"	Recommend constructing water bars at 20m intervals. Build to cover the entire road, can be placed in either direction but should depend on observed direction of water flow.	

VII. CONCLUSIONS

- The forest is recovering through natural regeneration. Recession, for example Harungana-dominated vegetation can recede to herbaceous cover if they are not succeeded in their approximately 15-yr lifespan, is a possibility at this site (L. Holloway, personal communication, TAMS Project, Conservation International). We propose planting the secondary and primary forest trees available in the nurseries on site under the cover of these pioneer species to minimize the possibility of recession in key areas. We also recommend thinning the pioneer species growing along the road edge by transplanting those Harungana and Solanum into the main road bed. This will accomplish two goals: 1) thinning will increase the success of secondary forest seedlings trying to establish on the road edges, and 2) transplanting these young trees into the compacted road area will increase mulch in that area and promote natural regeneration and it will facilitate corridor formation for wildlife. The operations of Latitude Timber nearly severed the unique Ankeniheny-Zahamena corridor and the associated carbon conservation corridor, so any steps to facilitate natural regeneration in this important area should be taken.

- At this point, there do not seem to be major incursions of invasive species into this area (e.g. *Clidemia hirta* that dominates in savoka environments). If non-native invasive species begin to be observed, we recommend immediate attempts at eradication to preserve the integrity of this unique forest system (L. Holloway, personal communication).

- Erosion, gullying, landslides, and bridge washouts have rendered the road impassable to vehicles. This is an excellent development, which works against further exploitation of the area. The road should not be repaired or maintained.

- There do not seem to be major downstream water-quality impacts at this time due to the road construction because of natural buffering by the forest.

- National protocols are needed for construction of roads in forested and other natural areas. Revegetation and erosion-control activities should occur simultaneously with road construction, and provisions must be made to include natural corridors or bridges across the road for wildlife movement.

- Capacity-building for ecological restoration is a priority. The TAMS project is developing this capacity in this region, but national capacity building is a priority. Capacity-building must include professionals at all levels of Eaux et Foret AND local villagers that are likely to be tasked with "sustainable exploitation" as part of management transfer agreements without having any true understanding of what "sustainable" looks like on the ground.

- Ambohilero is an unusual opportunity to observe and study passive restoration in Madagascar. The logging operations in this regions have impaired ecosystem function in ways very similar to forest conversion to agriculture (L. Holloway, personal communication), and so lessons learned at this site can be translated to multiple other similar situations. This unique opportunity at Ambohilero is mostly a result of the isolated nature of the area and the low level of use, even as a throughway by locals. The team found very little evidence of small-tree cutting or other disturbance by locals since the termination of Latitude Timber operations (with the exception of the gold mining operation). The presence is mostly limited to zebu and the few locals who herd them, as well as the occasional traveler walking to or from Bemainty. This very low level of disturbance following a catastrophic upheaval is an unusual situation in Madagascar and provides the opportunity to learn from long-term monitoring of both passive and active forest restoration if future exploitation is limited.

- The incursion of the illegal logging road into pristine rainforest habitat has important consequences for the endemic flora and fauna of this corridor region. While we are trying to quantify the effect of this activity on the flora and the responses of the flora to this perturbation, we are unable during such short expeditions to quantify the impact to the fauna. We did observe a diversity of lemur species along the road, including *Indri indri*, *Propithecus diadema*, *Eulemur fulvus rufus*, *Avahi laniger*, *Microcebus murinus*, and *Cheirogaleus major*, but we did not conduct systematic surveys to determine abundance. We did observe two adult *Propithecus diadema* (IUCN-Critically Endangered) vertically jumping across a section of road where the roadbed was 30m wide and there was only shrubby vegetation for 15m on both sides of the main road before the lemurs could reach trees large enough to climb. More systematic studies are needed to understand how different species are affected by the road, such as which species are capable of crossing it and how different species may avoid or be attracted to this new edge habitat. It is also important to minimize human access to this region as much as possible, to minimize hunting impacts in areas previously isolated from this pressure. Villagers in Bemainty mentioned that in the past, they were able to hunt and kill “greater than 10 lemurs per day” but that it was now impossible to find that many lemurs near their village. There is a real risk that they will start to use these newly available regions of forest made accessible by the road to hunt lemurs. Environmental education is needed on this subject.

VIII. LITERATURE CITED

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APPENDIX 1: GPS COORDINATES OF BOTANY PLOTS

Botany Transects (3 plots per transect, See Fig 5 for edits)	South	East	Altitude (m)	GPS Reading Accuracy (m)
A (plots 1-3)	17° 59’29.0”	48° 35’47.5”	1179	7.2
B	17° 59’20.1”	48° 35’30.9”	1170	8.8
C	17° 59’17.3”	48° 35’10.1”	1247	5.4
D	17° 58’58.4”	48° 34’59.9”	1248	5.6
E	17° 58’22.7”	48° 35’02.2”	1201	12.6
F	17° 58’11.0”	48° 34’41.6”	1201	5.9
G	17° 58’12.2”	48° 34’15.2”	1314	5.5
H	17° 59’23.0”	48° 36’26.7”	1173	7.3
I	17° 59’35.1”	48° 36’00.3”	1233	9.7
J (Plots 28-30)	17° 59’19.1”	48° 35’47.2”	1147	12.6

APPENDIX 2: PHOTO PLOT ID

Photo Plot ID	South	East	Width of roadbed 2005 (m)	Width of roadbed 2007 (m)
DP1	17° 59’20.8”	48° 36’42.9”	5.12	1
DP2	17° 59’22.7”	48° 36’26.8”	4.26	3.60
DP3	17° 59’33.7”	48° 36’12.0”	4.30	NA
DP4	17° 59’40.0”	48° 35’58.8”	5.70	1.60
DP5	17° 59’34.0”	48° 35’51.2”	10.32	1.50
DP6	17° 59’22.6”	48° 35’43.0”	18.0	10.32
DP7	17° 59’20.8”	48° 35’35.7”	9.10	5.40
DP8	17° 59’13.7”	48° 35’23.9”	9.0	NA
DP9	17° 59’15.6”	48° 35’12.2”	14.48	7.0
DP10	17° 59’08.2”	48° 35’05.6”	18.0	6.4
DP11	17° 58’55.0”	48° 35’01.8”	8.40	5.0
DP12	17° 58’41.4”	48° 35’01.4”	18.0	NA
DP13	17° 58’25.7”	48° 35’03.5”	22.0	11.6
DP14	17° 58’21.6”	48° 34’55.2”	12.0	11.8
DP15	17° 58’12.6”	48° 34’42.5”	19.0	6.50
DP16	17° 58’08.8”	48° 34’34.5”	12.0	6.20
DP17	17° 58’12.7”	48° 34’16.9”	7.0	6.45
DP18	17° 58’06.5”	48° 33’59.4”	30.60	9.50
DP19	17° 57’58.8”	48° 33’51.7”	12.0	9.50
DP20	17° 57’46.2”	48° 33’39.4”	15.0	11.60
DP21	17° 57’50.1”	48° 33’23.5”	10.5	5.7
DP22	17° 57’48.3”	48° 33’14.0”	12.50	6.50
DP23	17° 57’57.1”	48° 33’02.9”	10.0	6.4
DP24	17° 57’58.9”	48° 32’52.4”	9.0	7.20

APPENDIX 3: WATER BAR

Source: Virginia Department of Forestry. 2005. Forestry Best Management Practices for Water Quality. Richmond, Virginia. Pages 143-144. Available at: http://oep.berkeley.edu/pdf/FireProjects/OtherDocs/RoadBMPs.pdf.

Definition: A diversion dam constructed across a road or trail to remove and disperse surface runoff in a manner that adequately protects the soil resource and limits sediment transportation.

Purpose: To gather and shed surface water off a road, firebreak, trail, etc.; prevent excessive erosion until natural or artificial revegetation can become established; and to divert water from an inside (uphill) ditch.

Conditions where practice applies: This is a practice that can be applied on limited-use roads, trails, and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface water runoff may cause erosion of exposed mineral soil.

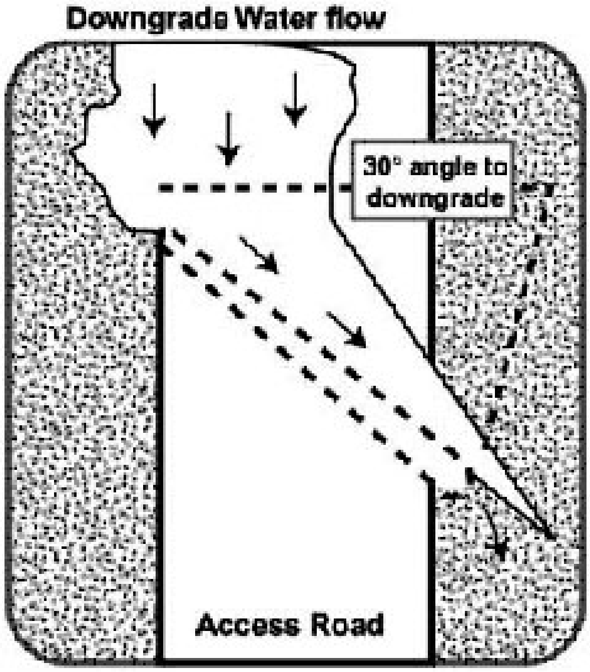
Recommended specifications:

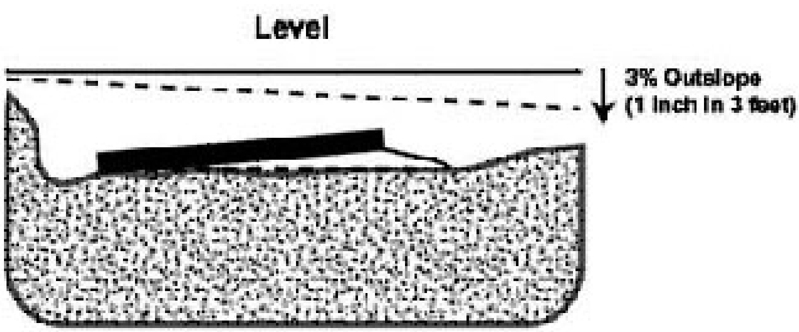
- Water bars should be placed at an angle of 30 to 45 degrees to the road, firebreak, or trail. Water bars are not dams. Water bars intercept and/or divert surface water runoff.
- The outflow end of the water bar should be fully open and extend far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor. The outlet should fall no more than 2%.
- The uphill end of the water bar should be tied into the cut bank of the road or trail, or into the upper bank of the road or trail.
- Specifications for water bar construction on forest roads, trails, and firebreaks must be site specific and should be adapted to existing soil and slope conditions.

Recommended water bar spacing along roadways

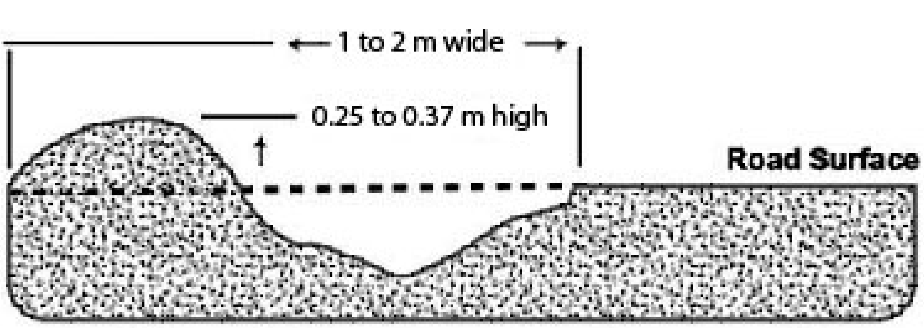
Road Grade (percent)	Distance Between Water Bars (m)
2	75
5	40
10	25
15	20
20	13
30	10

WATER BAR





Road Surface and Water Bar Pitch



PROPERTY RIGHTS, ENVIRONMENTAL SERVICES AND POVERTY IN INDONESIA

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BASIS BRIEF
Collaborative Research Support Program

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Property Rights, Environmental Services and Poverty in Indonesia

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Fighting poverty, protecting the environment

In 1999, Mr. Ading Suwarna, the leader of the village of Tribudi Syukur in Sumatra, Indonesia, heard from a local forest officer about a new community forestry program providing farmers with long-term licenses to use degraded protected state forest land for coffee production. The requirements were that the farmers protect the remaining forest, plant environmentally-beneficial agroforestry trees in their coffee plantations, and use appropriate soil and water conservation practices.

This program offered a new and potentially more effective approach to achieving sustainable forest management in Indonesia. Several times in the previous two decades, coffee farmers in Tribudi Syukur and many other communities had been forcibly evicted from state forest land areas, their plantations destroyed, and trees planted by the government. Such efforts did not produce lasting protection or restoration of the forest areas, which were ravaged by subsequent fires and illegal encroachments. The new community forestry, or *Hutan Kamasyarakatan* (HKm) program, sought a different approach: reward farmers with increased tenure security in already degraded areas in exchange for their cooperation in protecting the remaining forests and managing the land they use more sustainably.

Mr. Ading Suwarna organized a group of 493 farmers to apply for a license from the HKm program. With assistance from a forest officer they were able to complete the application, including a detailed map of the areas proposed for protection and sustainable use and a specific management plan. In 2000, this group of farmers obtained their license and began their forest-management activities, including organizing a local group of rangers to monitor remaining forest areas, obtaining and planting agroforestry seedlings, and conducting regular meetings.

The impacts of this program on the sustainability of forest use and on poverty in Indonesia are not yet known. Tribudi Syukur's experience suggests that providing such rewards in exchange for environmental services is a promising approach, but it raises several issues worthy of investigation. How do people become aware of and gain access to such a program? Are only "well-connected" villages with knowledgeable leaders able to take advantage? How do community members organize themselves to apply and achieve the management objectives of the program? Do they build upon prior successes in organizing collective action within the community? Who gains and who loses from these activities? Do such programs actually provide sustainable environmental benefits, and what impacts do they have on poverty? Providing answers to such questions is the goal of this BASIS project.

Empowering rural users of resources

Forest conservation in developing countries stands a better chance of success if local inhabitants see economic opportunity in protection rather than destruction of natural areas—this idea has gained credence in recent years. The past decade has seen growing interest in compensating local people directly for providing environmental services such as biodiversity conservation, carbon sequestration and watershed protection. While high-profile payment for environmental service (PES) programs have emerged in Costa Rica and other Latin American countries, they remain uncommon elsewhere in the developing world.

Environmental service reward mechanisms generally entail a shift in the traditional attitude toward rural natural resource users. Traditionally, rural people living in or near protected areas have been viewed as troublesome squatters; evicting them or sharply curtailing their land use activities were seen as the best way to improve land management. A subsequent approach, known as integrated conservation and development programs (ICDPs), sought to build goodwill with local people by bringing them development benefits in the hope of shifting the local economy away from protected areas, but it did not directly link benefits to provision of environmental services. Rewarding people for environmental services builds on the idea of creating goodwill and takes the additional step of making the receipt of benefits contingent on protection of the resource.

While this represents an improvement over previous approaches to protecting environmentally-sensitive ecosystems, PES introduces challenges of its own. Problems of identifying and measuring environmental services are difficult in many contexts, and hopes for using PES to benefit poor people are balanced by fears that it might bypass poor land users or even further marginalize their access to land and resources. Challenges related to high transactions costs of dealing with small landholders and unclear property rights in areas with high conservation value would need to be overcome. It is usually easier and less expensive to make and enforce contracts with a few large landowners rather than thousands of smaller ones, and it is easier and more affordable for large landowners to set aside large areas of land in a long-term contractual arrangement than for smallholders who need to meet subsistence production needs. Secure, officially recognized land tenure is typically required to enter into contractual relations, but poor farmers often lack such recognition. These constraints have been found to exclude smallholders from environmental service markets in many countries. In Costa Rica, for example, in some areas the largest 3% of landholdings accounted for the majority of contracts. Moreover, where land rights are unclear, there are concerns that PES systems might lead powerful people to usurp otherwise marginal lands and evict poor land users.

A range of PES mechanisms are operating in developing countries, particularly in Latin America, but they are still nascent in Asia. With funding from the International Fund for Agricultural Development, the World Agroforestry Centre (ICRAF) established the RUPES (Rewarding Upland Poor for Environmental Services) project in 2001 to address possibilities for these mechanisms in Asia, with particular emphasis on potential for the upland poor to benefit. RUPES works with international, national and local partners in building working models of best practices for environmental service agreements adapted to the Asian context. It conducts action research at sites across Asia to examine the provision of environmental services, who benefits, who pays, and the institutional and policy environment needed to enable fair and equitable distribution. RUPES takes an inclusive view on payment, including rewards that provide upland farmers with enhanced land tenure security in exchange for adhering to land use agreements. RUPES calls such arrangements Rewards for Environmental Services (RES).

Who benefits?

BASIS researchers are working with RUPES to examine RES experiences in Indonesia, focusing on (1) the social-spatial placement of RES mechanisms, (2) the within-village distribution of costs and benefits of RES mechanisms, particularly those related to enhanced property rights, and (3) the most appropriate institutional arrangements to enhance the benefits of RES for the poor. The research program operates in the Sumberjaya subdistrict, where RES mechanisms are being used for forest and watershed rehabilitation and protection services.

The central hypothesis of this research is that environmental service reward mechanisms may provide marginalized social groups with new opportunities for generating income, obtaining more secure rights to land and water, and inclusion in environmental governance processes. There are two ancillary hypotheses. First, due to limited spread of information and incomplete appreciation of the opportunities, there is a tendency for RES mechanisms to be located in

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The investigation of alternative institutional mechanisms to make RES work successfully will be conducted through a combination of group- and individual-level analysis. Key informant and group interviews will be conducted with potential suppliers of environmental services (upland farmers), intermediaries (e.g., NGOs and the Forest Department) and potential demanders of environmental services (e.g., the hydroelectric power company) to determine the types of mechanisms most likely to be compatible with the incentives and expectations of different stakeholder groups, the key attributes of those mechanisms, and the characteristics of the respondents likely to shape their preferences.

After developing profiles of a number of feasible RES mechanisms, a survey will be administered to a subsample of the households involved in the survey described above. An econometric model will be estimated that relates preferences for different RES mechanisms to attributes of the mechanisms and respondent characteristics as explanatory variables. Results will illustrate attributes of greatest importance in each study site and the way that preferences vary across key subgroups, including people of different welfare and livelihood characteristics.

Policy implications

Compensating land users for delivering environmental services offsite is a promising new approach for protecting natural resources. It offers improvements over past command and control systems, which created enmity between local people and the authorities without achieving great success, and ICDPs, which built better relations but failed to create strong incentives to protect natural resources. Despite its advantages, however, early experience with RES mechanisms shows numerous challenges.

In particular, making a rewards system work to connect the payment with service delivery is tricky. Too often better-off people capture most of the benefits. Continued experimentation is needed to overcome these challenges. In addition, environmental services mechanisms are very rare in Asia. This BASIS research offers the opportunity for an early analysis of the ways in which Asian nations might proceed with environmental service schemes that draw from the Latin American experience while continuing to develop new innovations.

Suggested Reading

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communities with high levels of interaction with the outside world, with their actual ability to efficiently provide the environmental service only a secondary criterion. Second, there is a tendency for the benefits of RES to be captured by advantaged households within communities. The research will investigate these hypotheses, with a goal of determining ways in which RES mechanisms can be designed to reduce or overcome these tendencies.

Discussions with farmers in Sumberjaya reveal their conviction that HKm offers them the opportunity for a secure livelihood. Some suggest that it will bring them into the mainstream of society, no longer living as outlaws who have to bribe forest officers to continue earning their living on restricted public land. They describe the steps they are taking to manage previously deforested land in a sustainable manner and protect remaining natural forests, acting for the first time as partners with the government. This situation suggests that land rights can be used as an environmental service reward mechanism. It presents an opportunity to test the hypotheses. In the Sumberjaya context, this translates into several key research questions.

- Can secure land tenure through HKm be utilized as a reward mechanism to encourage farmers to utilize land resources sustainably and protect natural forest areas? What impacts does it have on watershed and forest protection?
- Are HKm agreements placed in better-connected communities as opposed to those where they hold the greatest promise to deliver environmental services?
- If HKm agreements change the allocation of land, labor and capital, who gains or loses from these changes? Are the benefits of HKm captured primarily by better-off people in the communities where it has been implemented? What particular issues arise when the reward mechanism involves secure land rights as opposed to monetary payments?
- What institutional mechanisms can be used to help mitigate unintended negative outcomes or spread the benefits of HKm more widely? For example, what types of rewards are most preferred by potential providers of environmental services, and how do preferences vary within and across communities? What strengths and weaknesses characterize alternative institutional arrangements concerning transactions costs, communication, conflict management, and enforcement of rules? What institutional changes could be introduced that might strengthen the link between receiving the reward and providing the environmental service?

Study design

The questions to be addressed in this study require a combination of qualitative and quantitative research methods, which will be integrated with ICRAF's biophysical modeling work and the action research under RUPES. In Sumberjaya, community- and household-level interviews are being undertaken to generate data for analysis. At the community level, investigations focus on the processes that determine how communities learn about the program, form into the groups that are required to apply for the program, go through the application process, obtain the license, and carry out their responsibilities. The emphasis in this portion of the research is on questions related to bridging and bonding social capital. Bridging social capital is the network of social relationships that brings access to economic opportunities and special programs. Do communities with good connections to the right people gain access to HKm before others? Bonding social capital is the set of social relationships that enables groups to work collectively in an effective way. Are there identifiable factors that characterize those groups that have come together to benefit from HKm and delivered on their responsibilities?

Household level econometric analysis will focus on HKm's effects on people's land use and wellbeing. Utilizing a random sample of people using different types of land, such as privately owned land and forest land with and without HKm agreements, the investigation will focus on differences in the extent to which they adopt environmentally beneficial agroforestry systems, and differences in benefits they obtain as indicated by crop income and land values.

This analysis will be based on measurable indicators of performance, such as the density and species composition of agroforestry plantations, adoption of certain conservation practices, and levels of crop income and land value. It will seek to understand how the land use systems have changed since the late 1990s when people first returned to these lands after being evicted by the government. Analysis also will seek to relate these changes to a variety of factors, not only the ownership status of the land but also various personal and location-specific characteristics that might affect the outcomes of interest.

Program of Payments for Ecological Services in Costa Rica

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Program of Payments for Ecological Services in Costa Rica

Dr. Edgar Ortiz Malavasi[1]
Dr. John Kellenberg[2]

Introduction

The most common approach to promote forest ecosystem conservation and combat land degradation is the development, introduction and promotion of sustainable production systems. Such approach is usually accompanied of indirect incentives such the acquisition of infrastructure, equipment, product marketing, temporary payments for labor, food for labor, etc. The assumption is that new technologies will be adopted, that a market for the derived products will develop, and that they will generate higher incomes to land owners, creating an incentive to maintain the forest ecosystems. An alternative approach to encouraging the conservation and restoration of forest ecosystem is to pay for conservation performance directly to private lands owners (Ferraro and Simpson, 2000). In this approach, those that benefit from the provision of environmental services, derived from land uses and production systems that improve the environment and life quality, make payments to those land owners that supply the services (i.e., to those that adopt the desired land uses and production systems). In the case of land uses such as forest management, commercial reforestation, as well as forest conservation, the payments for environmental services are additional to the incomes from forest products sales, therefore, they help to improve the irregular cash flow frequently seen in forest production systems.

The Costa Rican Payments for Environmental Services Program (PESP) is an application of this approach. In this system, landowners receive direct payments for the ecological services which their lands produce when they adopt land uses and forest management techniques that do not have negative impacts on the environment and which maintain people's life quality. Costa Rica's Forest Law recognizes four environmental services provided by forest ecosystems: (i) mitigation of GHG emissions; (ii) hydrological services, including provision of water for human consumption, irrigation, and energy production; (iii) biodiversity conservation; and (iv) provision of scenic beauty for recreation and ecotourism.

The Costa Rican Payments for Environmental Services Program (PESP), which is executed through the *Fondo Nacional de Financiamiento Forestal* (FONAFIFO) and the *Sistema Nacional de Areas de Conservacion* (SINAC), aims to protect primary forest, allow secondary forest to flourish, and promote forest plantations to meet industrial demands for lumber and other wood products. This paper provides a brief description of the origin of the program, and the way it is presently designed.

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Main sector issues and strategy

Costa Rica experienced one of the highest rates of deforestation worldwide during the 1970s and 1980s. In 1950, forests covered more than one-half of Costa Rica; by 1995, forest cover had declined to twenty-five percent of the national territory. Approximately sixty percent of forest cover, totaling 1.2 million hectares, is on privately owned lands outside of national parks and biological reserves. World Bank estimates indicate that eighty percent of deforested areas, nearly all on privately owned lands, were converted to pasture and agriculture. Deforestation was principally driven by inappropriate policies including cheap credit for cattle, land-titling laws that rewarded deforestation, and rapid expansion of the road system. These policy incentives have since been removed and Costa Rica has become one of the world's leading proponents of environmentally sustainable development. Due to the forest conservation policy and economic factors affecting agricultural production, deforestation rates have slowed considerably (see Figure 1).

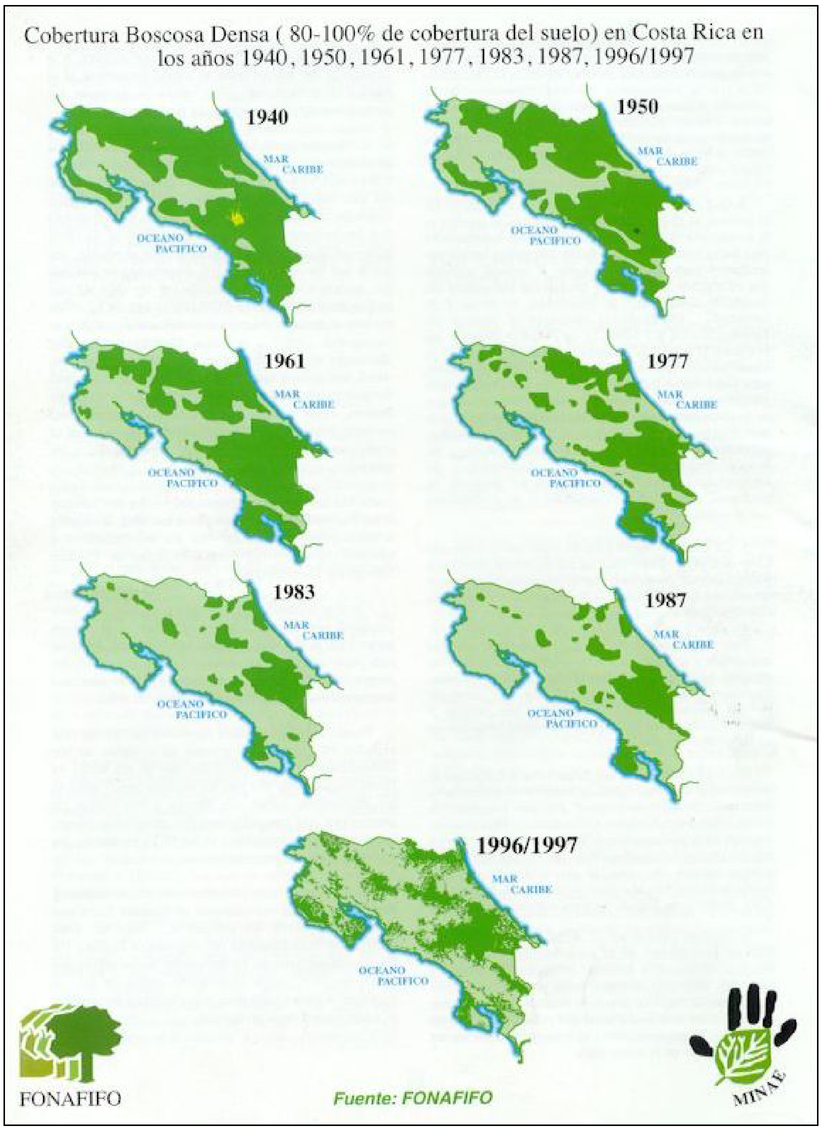

Figure 1. Forest cover changes in Costa Rica from 1940 to 1997/1997. Source: FONAFIFO 2001

A World Bank review of deforestation in Costa Rica carried out in the early 1990s identified three principal types of forest intervention in Costa Rica: (i) clear cutting to change the use of lands under forest cover; (ii) selective cutting of large, valuable trees in primary or secondary forest; and (iii) exploitation by owners of pasture areas that contain patches of forest cover. The study confirmed that clear-cutting and selective logging are principally driven by economic interests. While loggers play an important role in such activities, the main motivation for these processes comes from landowners seeking to obtain revenue from timber sales or agricultural activities. Environmental concerns tend be external to decisions made by landowners when they are not directly related to on-site productivity.

Kishor and Constantino (1993) also showed that returns from land use change (i.e., deforestation), are always greater than returns from natural forest management. At low interest rates, the conversion to forest plantations dominates the lower-yielding natural forest management. At higher discount rates, the landowner's greatest profit is obtained by clear-cutting the forest (Chomitz et at, 1998). An additional problem to promote traditional forest production activities is the irregular distribution of incomes generated by wood products sales. In the case of reforestation, it requires an inversion of near US$ 600 at the beginning of the rotation – that is, during years 1 to 5 – but the incomes from wood sales are obtained 10, 12 or even 15 year later. Table 2 shows an example of the distribution of the production costs and incomes from reforestation using melina (***Gmelina arborea***) and teak ***(Tectona grandis***). The table shows that the distribution of incomes are unevenly distributed during the rotation period, and therefore small or medium farmers, who normally need constant incomes to satisfy their needs, do not find the economic returns sufficiently attractive to invest in small-scale reforestation, making other land use activities (e.g. cattle-ranching and cash crops) the preferred option (FONAFIFO, 2001).

Costa Rica's efforts to internalize environmental values provided by forest ecosystems date back to 1979, with the passage of the first Forestry Law and the establishment of economic incentives for reforestation. Subsequent laws strengthened incentives for reforestation, broadening opportunities for landowners to participate in reforestation programs and making the program accessible to small landowners within rural areas.[3]

Costa Rica adopted Forestry Law No. 7575 in 1996. It recognizes four environmental services provided by forest ecosystems, provides the legal and regulatory basis to contract with landowners for environmental services provided by their lands, empowers FONAFIFO to issue such contracts for the environmental services provided by privately-owned forest ecosystems, and establishes a financing mechanism for this purpose.

The Payments for Environmental Services (PES) Program

The Payments for Environmental Services Program (PESP) aims to protect primary forest, allow secondary forest to flourish, and promote forest plantations to meet industrial demands

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[3] In order to accomplish these objectives, Forestry Law 7032 was passed in 1986 that created the Forest Credit Certificate ("*Certificado de Abono Forestal*" or CAF), which provided incentives for reforestation activities. In 1990, the CAF was expanded to include sustainable forest management (CAFMA) and in 1995, the CAF was expended to forest conservation (CAF-2000).

for lumber and paper products. These goals are met through site-specific contracts with individual small- and medium-sized farmers. In all cases, participants must present a sustainable forest management plan certified by a licensed forester, as well as carry out conservation or sustainable forest management activities – depending on the type of contract – throughout the life of individual contracts. Management plans include biophysical information on land, and specific actions for prevention of forest fires, illegal hunting, illegal harvesting, and monitoring schedules. Commitments associated with the environmental service contracts are registered with the deed to the property, such that contractual obligations transfer as a legal easement to subsequent owners for the life of the contract.

Landowners cede their GHG emissions reductions rights to FONAFIFO, to be sold on the international market. It bears noting that the ESP program sets different regulations for indigenous territories; experience indicates that indigenous territories have clear land boundaries but they do not always hold individual titles to their land nor have legally established associations as representative of the territory. As a result, FONAFIFO exempts indigenous territories from complying with land ownership regulations (see Table 1).

Table 1. Contracts of Payments for Environmental Services by Land Owner Type

Contract	Maximum Area (ha)	Land Owner Type
Individual	300	Individual land owner
Global	300 by land owner There is no limit for NGO	Individual small and medium land owners associated to a local NGO
Indigenous Reserve	600	Indigenous Reserve Development Association

At present[4], there are three different types of PES contracts. They are (see also Table 2):

- Forest conservation contracts: US$210 per hectare (equivalent to $42 per year per hectare), disbursed evenly over a five-year period, for forest conservation easements. Eighty-five percent of contracts in the PES program to date support forest conservation easements (see Table 3), which target the conservation of vegetative cover in primary and secondary forest areas. Contracts are for five years, but can be renew depending upon funds availability.

- Sustainable forest management contracts: US$327 per hectare, disbursed over a five-year period, for sustainable forest management easements. Nine percent of contracts in the ESP program support sustainable forest management. Landowners must make a commitment to maintain forested areas for a period of 15 years.

[4] The levels of the payments change every year to adjust them due to inflation (1US$ = 346 colones on February, 2002).

- Reforestation contracts: US$537 per hectare, disbursed over a five-year period, for reforestation easements. Landowners must make a commitment to maintain reforested areas for a period of fifteen to twenty years, depending upon tree species. Six percent of contracts in the ESP program support reforestation of degraded and abandoned agricultural lands.

Table 2. Distribution of the payments by contract type during year 2001

Contract Type	**Total Payment (US$)***	**Distribution by year**				
		1	**2**	**3**	**4**	**5**
Forest Conservation Easements	210	20%	20%	20%	20%	20%
Sustainable Forest Management	327	50%	20%	10%	10%	10%
Reforestation	537	50%	20%	15%	10%	5%

US$ 1 = 346 colones

From a conservation perspective, the PESP provides market-based incentives to conserve natural forest ecosystems. These economic incentives help maintain habitats that are critical to a rich, globally important biodiversity, and have the potential for helping to maintain biological corridors linking national parks and biological reserves. Approaching forest conservation through the PESP program is akin to the system of conservation easements that are widely used in the United States and European countries. Since 1997 to year 2001, near 283,384 hectares of forests have been incorporated into the program. During this period FONAFIFO has paid to private landowners approximately US$57 million (see Table 3 and 4).

Table 3. Total area and number of participants by PES contract type and year

Year	Forest Conservation Easements	Sustainable Forest Management	Reforestation	Total	Number of contracts
1997	**88,829.8**	**9,324.5**	**4,629.4**	**102,783.7**	**1,531**
1998	**47,803.8**	**7,620.4**	**4,172.5**	**59,915.7**	**1,021**
1999	**55,776.0**	**5,124.8**	**3,156.0**	**64,782.0**	**925**
2000	**26,583.2**	**0**	**2,456.8**	**29,040.0**	**501**
2001	**20,629.0**	**3,997.0**	**3,281.0**	**27,997.0**	**483**
Total	**23,9621.8**	**26,066.7**	**17,695.7**	**283,384.2**	4,461
%	**84.6%**	**9.2%**	**6.2%**		

Funding Sources

Principal sources of funding for the program include a tax on fuel sales (see Table 4), payments to FONAFIFO from private sector firms (renewable energy producers, and water blotters, see Table 5) for the conservation of critical watersheds, and through the sale of Certified Tradable Offsets (CTOs) derived from forest ecosystems.[5] The Global Environmental Facility has also donated US$ 8 million to FONAFIFO to support the program. US$ 5 million will be invested in direct payments for forest conservation contracts with land owners located in the Mesoamerican Biological Corridors in Costa Rica (MBC/CR), and US$ 3 million will be invested in increasing institutional efficiency of FONAFIFO, SINAC, and non-governmental organizations promoting conservation, reforestation, and sustainable management of forest ecosystems througth the PESP.

Table 4. National budget assignation to finance former *"Certificados de Abono Forestal"* (CAF) and the Program of Payments for Environmental Services.
From 1997 to 2002. In Millions of Colones/C.R.

Year	**Assigned Budget**		**TOTAL**
	CAF	**PES**	
1997	**¢ 1,789.0**	**0.0**	**¢ 1,789.0**
1998	**¢ 2,381.0**	**¢ 1,269.0**	**¢ 3,650.0**
1999	**¢ 1,590.0**	**¢ 2,406.0**	**¢ 3,996.0**
2000	**¢ 1,373.3**	**¢ 2,098.3**	**¢ 3,471.6**
2001	**¢ 1,251.0**	**¢ 2,345.2**	**¢ 3,596.2**
2002	**¢ 1,243.0**	**¢ 3,066.9**	**¢ 4,309.9**
TOTAL	**¢ 9,627.3**	**¢ 11,185.4**	**¢ 20,812.7**

Source: FONAFIFO, 2001

Benefits and target population

Important program benefits include the conservation and sustainable use of forest ecosystems in privately owned land outside of national parks and biological reserves. It empowers small- and medium-scale private landowners in the conservation and management of forest ecosystems and in making choices that contribute to sustainable development. It benefits regional users of hydrological services by supporting the provision of high water quality and hydrologic stability from forest ecosystems. Environmental benefits related to biodiversity conservation, and mitigation of GHG emissions, likewise accrue to the global community.

[5] Certified Tradable Offsets (CTOs), or "carbon bonds" are an environmental commodity that provides global environmental and economic benefits, representing internationally recognized Emissions Reductions of GHG expressed in metric tons of carbon. At the present only one sale of CTOs for 200,000 metric tons has been made.

Table 5. Agreements of payments for environmental services between FONAFIFO and Private Firms in Costa Rica.

Firm	Watershed	Watershed Area	Contract Area	Amount (US$)
Energía Global	Río Volcán Río San Fernando	5,870	4,311	53,340
Hidroeléctrica Platanar*	Río Platanar	3,129	-	-
Compañía Nacional de Fuerza y Luz	Río Aranjuez Río Balsa Lago Cote	9,515 18,926 1,259	5,000 6,000 900	5,188,400
Florida Ice & Farm	Río Segundo	3,870	1,000	272,727
TOTAL		**42,569**	**18,611**	**5,514,467**

Source. FONAFIFO.
*The contract with *Hidroeléctrica Platanar* has two modalities. US$ 15/ha/year for landowners with land title, and US$ 30/year/ha for landowners without land title.

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Direct payments as a mechanism for conserving important wildlife corridor links between Nairobi National Park and its wider ecosystem:

The Wildlife Conservation Lease Program

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Workshop 9
Conservation Incentive Agreements

Direct payments as a mechanism for conserving important wildlife corridor links between Nairobi National Park and its wider ecosystem: The Wildlife Conservation Lease Program

Dr. Helen W. Gichohi
African Wildlife Foundation

Introduction

Nairobi National Park is part of a much larger system comprising the Kitengela, the Athi and Kapiti plains to its south. The system, much smaller than it was at the turn of the century, is thought to have once contained the second largest migratory population after the Mara-Serengeti. The Athi-Kapiti plains comprise approximately 2,200 km^2 of open rolling land. Nairobi Park the only protected part of the system is a mere 114 km^2. The park serves as a dry season concentration area for the major wildlife migrants that make up over 50 % of the total wildlife biomass of the park. The Park is fenced on three sides and only the southern boundary marked by the river Mbagathi is open and allows the continuing movement of wildlife to the wet season feeding areas in the South. The Kitengela to its immediate south measures 390 km^2 and is used seasonally but also has a resident population of many of the herbivores represented in the park.

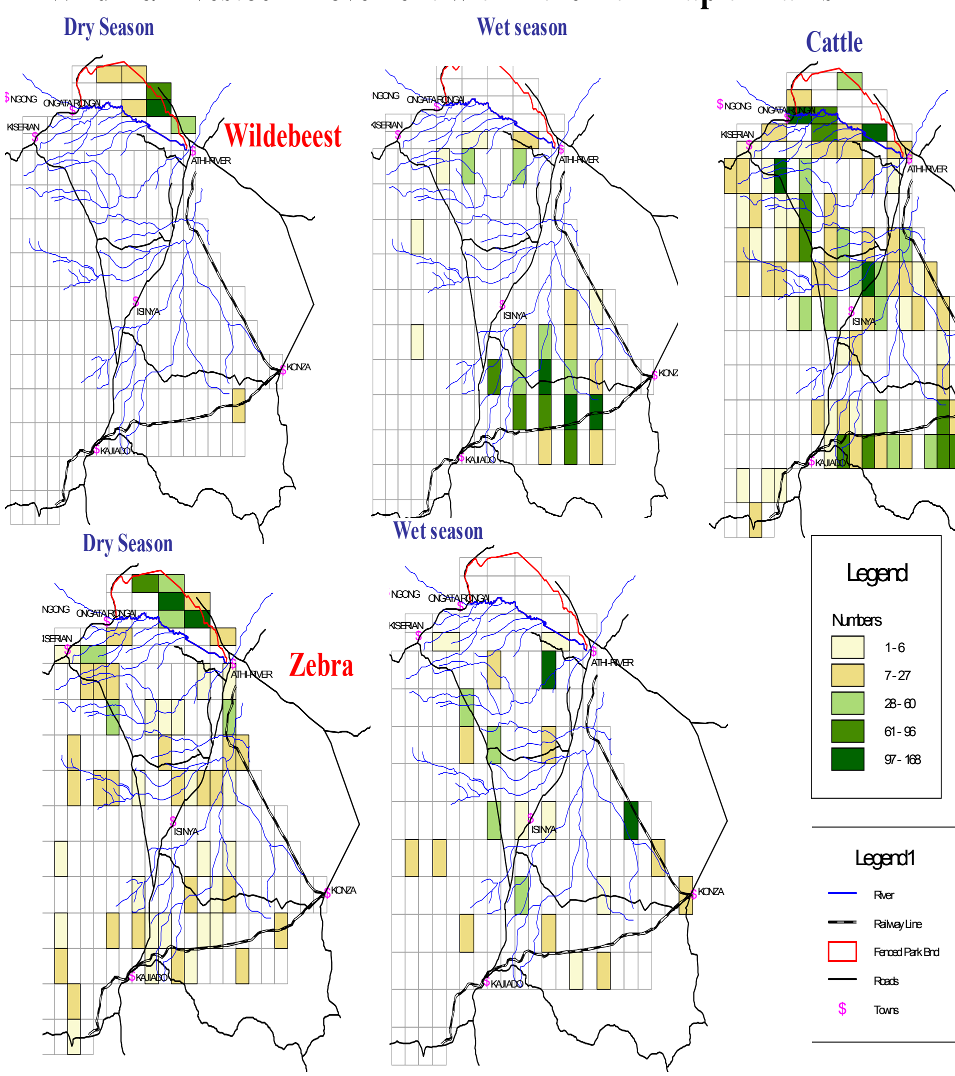
Livestock and large numbers of wild herbivores dominate the Kitengela, with wildebeest and zebra constituting over half the total wildlife population. Other wildlife species in the area include the Coke's hartebeest, Grant's gazelle, Thomson's gazelle, impala, eland and giraffe. Rhino and buffalo occasionally wonder from the park into the Kitengela. Predators such as lion, cheetah, leopards and hyena and a high diversity of birdlife are also present.

When the park was gazetted in 1946 it was immediately recognized that it was too small to meet the ecological requirements of the then large migratory wildlife. Kitengela plains and the Ngong Hills, which acted as drought refuge areas, were thus declared conservation areas, but unfortunately never gazetted.

Rapidly increasing human populations and changing socio-economic lifestyles leading to greater natural resource exploitation have been identified as the greatest threats to wildlife conservation within the rangelands the world over (WRI 1997, Ellis et al, 1999; Foran and Howden 1999). Within East Africa, changes in land policies and high human population growth rates coupled with rapid changes in people's expectations over the past few decades have resulted in the expansion of cultivation, growth in the number of permanent settlements, and urbanization and diversification of land-use activities around many conservation areas.

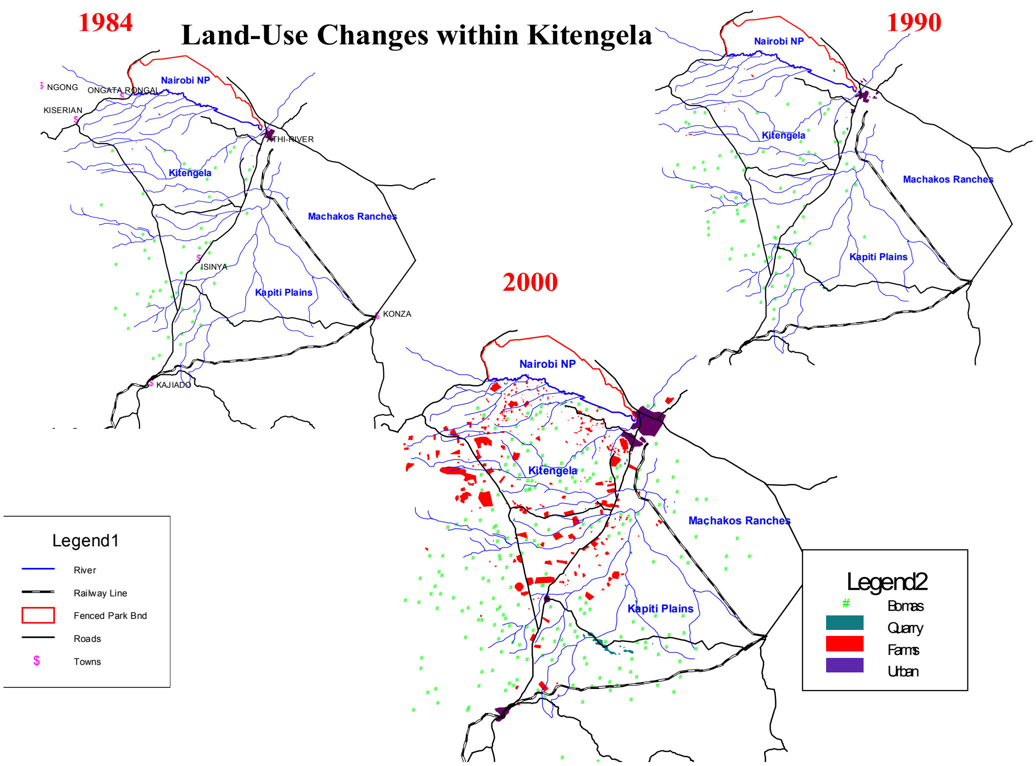
In the mid-sixties land privatization began for areas previously held as communal lands. The change in land policy from communal to group ranches was seen as a compromise between the government's preference for individual tenure and the production requirements of the semi-arid zones. These two forms of tenure which provided for large land holdings allowed for the great mobility needed by wildlife and livestock in the East African savannas as well as their coexistence. However, the system failed to operate as expected and the Maasai owners begun to push for sub-division. As a result the Kitengela group ranch measuring 18,292 with 214 registered members was subdivided in 1988 to individual landholdings (Kristjanson et. al. 2002). The subdivision has facilitated the rapid change in land with economic diversification from pastoral livestock to crop agriculture, quarrying and permanent settlement. In addition, its close proximity to the city of Nairobi has attracted industrialization (the development of the Export Processing Zone -EPZ) and an influx of non-maasai and increased the pressure for land for permanent settlement and speculation resulting in the rapid decrease in the per acre land holding. Consequences of these changes in land-use patterns include declining ecological, economic and social integrity of rangelands due to landscape fragmentation of landscape, declining rangeland productivity; diminishing wildlife migratory corridors, wildlife populations and diversity and cultural and economic diversification due to immigration (Gichohi et al. 1996).

Wildlife/Livestock Movement within the Athi-Kapiti Plains



As in many wildlife landscapes in East Africa, the majority of wildlife is found outside PA boundaries where they spend significant portions of their annual seasonal cycles, on private or communal land. Most of the parks are therefore not ecologically viable in the absence of these dispersal areas, especially for species that that require seasonal migrations (e.g. between calving and feeding grounds) to survive in large numbers.

Since the 1980s, vital wildlife areas of the Athi-Kapiti plains have progressively been partitioned and fenced off, reducing their accessibility to wildlife. Gichohi (1996) has reported that the area has experienced a substantial decline of wild herbivore populations, by approximately 50%, over the few years attributed largely to increasing human and livestock populations, changing land use, declining access to important resources and poaching. This reduction in wild herbivore numbers coupled with changes in distribution and use patterns have significant ecological impacts on the NNP and the entire ecosystem as is currently being demonstrated.



The Wildlife Lease Program

The Wildlife Lease Program inspired by Friends of Nairobi National Park (FoNNAP) and The Wildlife Foundation (TWF) is an attempt to halt the loss of important migration lands linking Nairobi National Park, the dry season concentration area with the wet season feeding areas in the Athi-Kapiti plains. The initiative supports the Kenya Wildlife Service's (KWS) objective of supporting an ecosystem management approach that takes account of the species and habitats inside the park as well as the entire ecosystem.

The local conservation community as well as local landowners, have struggled to find ways to arrest these negative trends of fencing, cultivation and settlement in areas immediately south of the park. Efforts to develop community-based tourism activities were unsuccessful due to the many conflicting interests and an inability to develop a common vision within what is a fairly diverse community in the

Kitengela. As a result activities inimical to wildlife conservation continued to expand and human wildlife conflict intensified.

In 1999, a pastoral household survey by the African Conservation Centre (ACC) was undertaken to examine the impacts of the wildlife corridor and the effects of the year round presence of particular species on the welfare of the community. The survey also assessed the acceptability of an easement programme to the landowners. The survey found that landowners in this area suffer frequently from wildlife–related problems. Over 93.5% of the households interviewed reported a very significant increase in human–wildlife conflicts caused mainly by shrinking land sizes, lack of economic benefits from wildlife, increasing human population, increased risks of human attack, severe competition for water and grass, and frequent predation (Mwangi and Warinda 1999). In 2000 the local community made an appeal to the International Livestock Research Institute (ILRI) to follow up on the ACC survey in order to provide to landowners an estimate of how much would be a fair price per acre to the landowners to allow continued access to wildlife.

The ACC/ILRI survey of 2000 indicated that most of the landowners were willing to leave part of their land open (0.5-250 acres) in order to accommodate wildlife in exchange for monetary gain. Based in part on the findings of the ACC/ILRI survey, in April 2000, with modest funding from The Wildlife Trust (USA), the Friends of Nairobi National Park (FoNNaP) and The Wildlife Foundation (TWF), a small initiative was launched to provide direct financial incentives for conservation in the form of cash payments to individual landowners in return for their voluntary entry into a **Wildlife Conservation Lease** (WCL) agreement. This lease program was officially inaugurated at the launching of the Nairobi National Park Migration Appeal in November 2000.

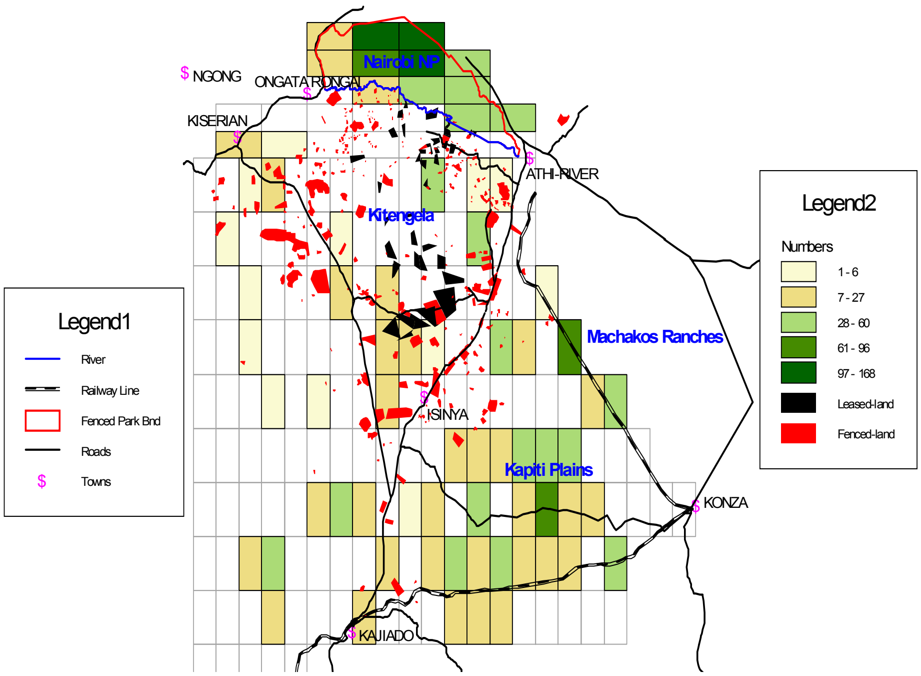
The WCL program began the pilot project with 214 acres owned by 2 households, growing to 2,708 acres by January 2001 and to 84 households covering 7,000 acres by April 2002. In July 2003, 115 households were signed up and a total of 8,400 acres were under this initiative. More families are on the waiting list with a total of more than 14,000 acres.

The project has depended on institutions external to the community interested in conservation of the greater ecosystem as well as conservation minded individuals in the community. It has also relied on external funding and plans are currently underway to raise 1 million USD to bring at least 60,000 acres of critical land under conservation management.

Issues of land in Kenya are highly contentious. The history of the creation of national parks, which alienated a lot of pastoral land, created a great deal of resentment against the national park movement. Any program associated with conservation and land are therefore looked on with suspicion and often assumed to be a precursor to the expansion of protected areas. At the advice of institutions and individual community members who had worked with the Kitengela community the lease was proposed as the easiest and best understood tool for use given the history of land in the area. The use of leases was also not new to many locals except in its application for wildlife conservation. With changes in land tenure from group ranch to individual ownership and as land holdings have diminished, the practice of leasing lands from neighbours or other community members for livestock grazing during crunch periods has grown. Using this well know system of ‘buying rights of access and use’ on private land it was easy to apply it to wildlife without arousing deep-seated suspicions over the potential loss of land.

To further convince them that the lease program posed no danger, the initiative relied on individuals from the local community to create interest and to allay fears. One of the individuals who acted as the initial champion for the lease program on the ground with FoNNAP is a member of the community. The participation of this bright, well educated Maasai landowner did much to galvanise action on the ground and had the impact of bestowing a rare confidence on the lease program in the minds of many less educated community members.

Zebra and Wildebeest Distribution, Fenced and Leased Lands in the Athi-Kapiti Plains



Implementation of the lease program

In return for agreeing not to fence, quarry, cultivate or subdivide the designated area of land, and to actively manage their land for wildlife and sustainable livestock grazing, TWF pays a fee of Kenya shillings 300/acre (approximately US$ 4 per acre) per year directly to the landowner. This arrangement is formalized through a written contract between the individual land owner and the WCL. Currently the WCL pays US$4 per acre per year, with a 5% base annual inflation factor built in.

The average participating household earns US$ 400-800/year from its WCL paid three times year at the beginning of the school term. Payments have therefore, been used mostly to support education of children in the participating families and is one of the reasons for its strong success.

Before land is brought under the protection of a WCL, several critical steps must be taken:

- Land must be confirmed to lie within the primary wildlife migration/dispersal area.
- Titles are checked to verify clear ownership, the recorded location of each parcel, and the exact number of acres owned by the household.
- Physical verification is also undertaken and measurements of areas around houses and livestock enclosures that will not be used by wildlife are taken. These are excluded from the lease as the WCL program only pays for open unfenced land.

A number of additional steps are undertaken to enhance the quality and control of the WCL program and to enhance its positive conservation and social benefits:

- The annual WCL fees are paid in three tranches, in an open ceremony held three times a year during the last weekend before schools resume. This has encouraged households to use the funds to pay school fees.

- Field representatives of The Wildlife Foundation are based on the ground on a full time basis in Kitengela to monitor conformance with the WCL program.
- Wildlife Conservation Lease statistics and payments are recorded by computer, and also manually in a ledger book at The Wildlife Foundation office.
- To facilitate greater community participation in achieving their common goals, a new association was formed by local landowners to provide a collective forum for discussions and decision making on wildlife matters: the Kitengela Ilparakuo Landowners Association (KILA). This association is acting as a focal point for discussing issues with other stakeholders involving the Wildlife Conservation Lease program and other issues relating to wildlife lands in Kitengela.
- Formalizes the WCL strictly between The Wildlife Foundation and individual landowners,
- Conducts all transactions openly and with full transparency.
- Distributes funds directly and equitably to every family in the program, based solely on the area of land under contract.
- The benefits are direct and families can individually decided on their economic priorities without reference to the wider community.

Key Partners

Several key partners have been involved in the program's implementation or supported the WCL program in various ways, either through funding or providing technical support.

FoNNAP, a voluntary membership organization initiated the project with support of the Wildlife Trust and was the initial home of the lease program. The International Fund for Animal Welfare (IFAW), East Africa has provided some funding. Three agencies have provided technical support, AWF legal inputs, ACC and ILRI critical information on wildlife movements as well as socio-economic data that has been used to support the program. Kenya Wildlife Service, the national agency responsible for wildlife conservation has also been very supportive of the program.

Successes of the lease program to date

The WCL initiative represents an innovative, "direct payment" approach to sustaining wildlife on private lands in an important and threatened grassland ecosystem in Kenya. It aims to protect and ensure sustainable management of this highly threatened yet nationally important ecosystem by countering the accelerating trend of land conversion through a combination of interventions that have provided direct benefits to the local community inhabitants, who as owners of land, have increasingly made land use choices that have been negative for wildlife conservation. The program has:

- Made direct payments to landowners for performing a valued service, that of conserving habitat and wildlife access. The link between the payment and conservation is therefore unequivocal.
- While the fee is modest, it has so far proven to be adequate to attract a large number of willing participants and to enable participating families to hold on to their land rather than sell it to meet short term cash needs.
- The combination of the program's fees and livestock yields are greater than can be realized by conversion to crop cultivation in that area and has therefore provided strong disincentives for farming.
- An obvious social benefit has been the improvement in school enrolment especially of girls, as more families are able to pay school fees.

Lessons from the lease program

- The value of providing financial payment that can be linked directly to wildlife conservation in an area where communities have very limited sources of income is high.
- The timing of the payment based on the community's request has yielded high social benefits and is helping the households under the program to educate their children.

- Though modest, the cash payments have enabled traditional Maasai families to hold onto their land in the face of heavy temptation to sell and to continue their traditional pastoralist lifestyle by helping them finance short-term needs for cash that often drive the sales.
- Individuals can act as catalysts to provide impetus to a program such as the WCL. This has been the case with the Kitengela lease program.
- The role of individuals from the community in galvanizing and providing confidence to the wider community has been valuable.
- Institutional partners have provided valuable information that has to focus the lease program spatially and to provide much needed socio-economic information that has helped provide strong justification and supporting data. In this way the TWF has been able to focus on its area of strength.
- The WCL program has also avoided another common problem with community conservation initiatives -- a focus on providing development benefits rather than achieving conservation.
- The WCLs must be combined with other mechanisms in order to secure important migration crossings at the Mbagathi river and critical calving grounds for wildebeest and zebra in the south eastern part in order to retain connectivity and function between vital parts of the ecosystem.

Challenges

Several key challenges to the program remain even as the popularity of the program grows and the benefits from it are realised by both the human community and wildlife.

The biggest challenge so far emanates from the rampant land sales that occur especially in the areas contiguous to the two tarmac roads that bound the Kitengela. Although the rate is slower now than it was five years ago, the fact that the newcomers often opt to fence their parcels continues to be a significant threat to the leasing process. A second challenge arises from the amount of the lease fee currently being offered. The USD 4 per acre is sufficient primarily for those who prefer a pastoralist way of life and who still own large tracts of land. The reason for this is high and rising value per acre of land. As the demand for land grows and the value per acre rises, younger people will find it difficult to resist selling especially as the sources of alternative income continue to be limited and the earnings from a combination of livestock and the lease remain modest.

The lease program needs to find ways to transition into multi-year contracts to improve planning and ultimately to perpetuate arrangements such as easements in order to assure the long-term availability of land for wildlife. Land purchase should also be considered in order to secure high value crossings points into and out of the park and lands under the lease program that come up for purchase.

Replication potential

The lease program is looking to raise a medium-sized grant from the GEF to help expand the project to meet the goal of 60,000 acres over the next 4 years. The proposed 4 year program would lay the groundwork for a longer term program that will demonstrate the effectiveness of the approach. During this period, it is intended that AWF will work with government and key partners to facilitate development of a national institution that will undertake similar work and apply this, other economic tools and where possible purchase land in priority conservation areas facing similar challenges of land fragmentation and conversion. These problems are expected to escalate as land is subdivided around prime wildlife areas in the Maasai Mara, Amboseli and Laikipia. Fundraising to establish a Trust Fund under the national Trust will follow. These processes are also intended to provide the impetus for the development of a supportive policy and economic framework for the application of these tools more broadly.

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The impacts of payments for watershed services in Ecuador

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The impacts of payments for watershed services in Ecuador

Emerging lessons from Pimampiro and Cuenca

Marta Echavarria
Joseph Vogel
Montserrat Albán
Fernanda Meneses

ENVIRONMENTAL ECONOMICS PROGRAMME

January 2004

International Institute for Environment and Development (IIED)

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Contents

1. Introduction

"Markets may be efficient, but nobody says they are fair. The question is: what do we owe the future?"

Robert Stavings, University of Harvard, in "The invisible green hand. A survey of the global environment", *Economist* 6 July 2002.

1.1 Background

As a reaction to the ineffectiveness of command and control environmental regulations, environmental policy makers have promoted market mechanisms to achieve ecological goals. In the past decade proposals to market the environmental services provided by forests have become a reality in a wide range of settings (Pagiola et al. 2002; Landell-Mills and Porras, 2002). A key area of interest is that of watershed services, for example, flow regulation, maintenance of water quality, control of soil erosion and sedimentation, and maintenance of the hydrological functions provided by forests. With this in mind, environmentalists and conservation-minded local authorities are proposing to pay landowners to protect forest cover and thus maintain or improve hydrological integrity. At present, the environmental effectiveness of these 'experiments' is still being evaluated (Johnson et al. 2001).

One of the questions that arises in relation to this issue is: what is the impact of 'environmental markets' on poverty? Through a worldwide study of green markets, the International Institute for Environment and Development (IIED) has found that in general it is assumed that the social impacts will be positive; however, these are rarely assessed (Landell-Mills and Porras 2002). The study examines 287 cases in which 'markets' are being developed for forestry services including carbon sequestration, wetlands, biodiversity protection and landscape beauty. "Markets" are deemed to exist where payment systems are set up such that beneficiaries of an environmental service compensate providers of that service. Payments may be in the form of financial or in-kind transfers. To this end, with the aim of undertaking a social assessment of environmental market mechanisms, research was carried out in several countries where markets are emerging or are already in existence (Ecuador, Costa Rica, the Philippines and Brazil), as means of extracting key lessons that could be applied in other countries.

Payments for environmental services are of great interest in Ecuador, particularly as a way to leverage funding for environmental protection. Payment systems are emerging, but because these experiences are recent little is known about their impacts on national or local well-being. Thus, the rationale for this research is to provide guidance in order to ensure that policies support payment systems that are beneficial to the poor, as well as the environment.

Two cases of payments for watershed services were selected for detailed analysis: Pimampiro and Cuenca. These two different cases were chosen to illustrate how municipalities are implementing or planning to implement payment systems to protect their watersheds. Pimampiro is a small town and provides an interesting pilot experience of paying landowners to protect their forest, the first such case in the country. Cuenca is a medium-sized city that has established an ambitious and integrated water resources management system and is interested in developing a payment system in the near future.

1.2 Project objectives and deliverables

The project set out to engage stakeholders in the evaluation of this emerging "market" for watershed services and its social impact.

The study consists of two documents that are separate but also complement each other. The first document, called *Markets or Metaphors? A Sustainable Livelihoods Approach to the Management of Environmental Services: two Cases from Ecuador*, written by Dr Joseph Vogel, is at the centre of the research. This document presents the results of the development of a methodology and its application in the field. It also includes an economic and legal analysis that demonstrates the importance of understanding and including social and cultural implications when developing a market for watershed services.

Vogel (2002) discusses the implications of "commodifying" the environment ("Does charging for water disrupt public order and moral conduct?"), presenting five key issues that should be considered by those interested in promoting water and watershed markets:

- access to common resources;
- the issue of private ownership;
- conflicts between upstream "sellers" and downstream "buyers";
- confusion between *de facto* control over the land and *de jure* right;
- water as a right versus water as a commodity.

The present document is descriptive in nature and provides a more detailed explanation of the Ecuadorian context and the "stories" behind the two cases. The project conclusions based on Dr Vogel's analysis and the opinions of the people interviewed are presented in order to present lessons for the future.

1.3 Data collection techniques

Ecodecisión, an Ecuadorian firm specialising in watershed environmental services and climate change mitigation, coordinated a research team from several institutions. Dr Joseph Vogel, Professor of Economics at FLACSO-Ecuador, was the Technical Director and directed the focus of the study, designed the methodology and analysed the data. Montserrat Albán, an economist from EcoCiencia, a national biodiversity research institution, was the research assistant in charge of the consultations and stakeholder interviews. Marta Echavarria, an environmental manager, acted as project coordinator.

To evaluate market mechanisms, Vogel (2002) developed a methodology that considers the impacts on the poor. Based on a critique of the Sustainable Livelihood Approach, Vogel recommends the use of *limits*, be they institutional, cultural or physical, as a guide for assessing impacts. Thus the methodology aims to "design a field instrument that can refine the researcher's subjective impressions as to what are the most relevant limits for the provision and consumption of environmental services".

The methodology is divided into the three areas, described below:

1. *The background preparation* entails the collection, synthesis and summary of all published and unpublished data in order to build on existing research and provide recommendations. Unpublished and published documents are identified and collected as

suggested by representatives from the different institutions participating in the studies, as well as other practitioners in academic, government and non-government organisations. A full list of the literature referred to is provided in the reference list. Key participants in the development of these cases, from implementing agencies or advisory bodies, were interviewed.

Subjective impressions should be identified and used to develop an instrument, which, unlike a survey, should consist of a list of statements in simple and jargon-free language. Those interviewed should not be asked open-ended questions but should be allowed to review bracketed phrases so they can choose the answer that best reflects their opinion.

Owing to possible literacy and numeracy problems, it may be necessary to reformulate the instrument into questions. As we all have opinions and biases, great care should be taken to avoid steering the interviewee towards an answer.

The content of the survey should be different for "buyers" (downstream water users) and "sellers" (upstream water suppliers).

2. *The field work* highlights the fact that "consultation with stakeholders", rather than "surveying" members of a community, is more conducive to collaboration given that in developing countries there is often mistrust of interviews. This is particularly true in settings in which payment systems are discussed and where people will answer strategically. It is important to allow sufficient time and space for people to reflect on the question and take their time to answer. It might be appropriate to offer some kind of compensation for people's time, but this will depend on the researcher. Only relevant and clearly defined data should be collected and the stakeholders' privacy should be respected.

   Based on the instrument designed by Vogel (2002), consultations took place in Pimampiro with 11 of the 20 members of the Nueva América Association who participate in the payment system, and 36 individuals from the town of Pimampiro; and in Cuenca with 24 people from the Yanuncay watershed and 49 ETAPA customers in the city of Cuenca. The tabulated results of these consultations can be found in the Annex 1.

3. *Analysis and recommendations* should be provided to all stakeholders after the statistical analysis is performed. Existing recommendations maybe reinforced or corrected after analysing the new data.

The time frame will vary according to the site and the stakeholders consulted.

1.4 Content of the report

Section 2 presents the national context relating to water resource management and describes the laws, policies and institutional organisation. This section also presents a summary of how watershed "services" are being discussed and developed nationally.

Sections 3 and 4 describe the features of the Pimampiro payment system and water resources management system of Cuenca's municipal water company, ETAPA. At the end of each section, impacts are assessed and the recommendations derived from the economic analysis are presented.

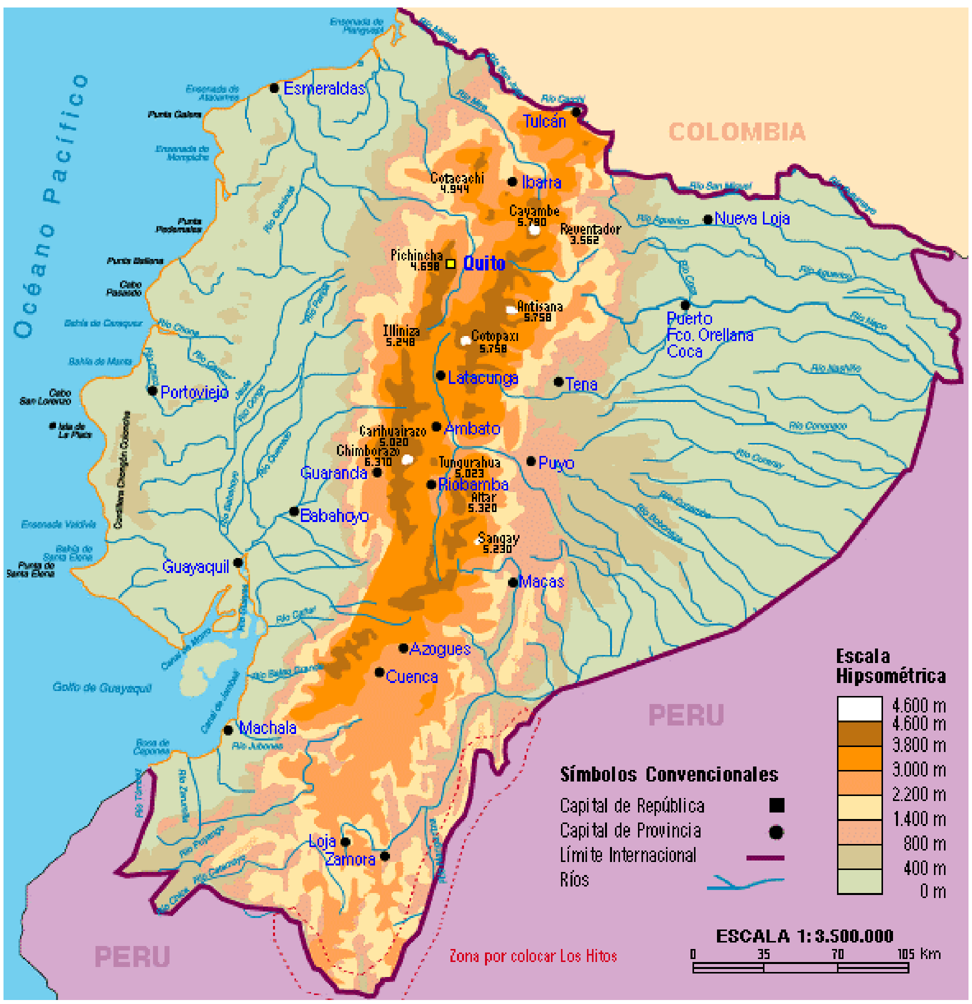
Section 5 presents the main findings of the preliminary assessment of Pimampiro and Cuenca, the process of creating the payment mechanisms, and finally the project's conclusions.

2. Water in Ecuador

2.1 Water scarcity

The Andes mountain range crosses the whole country (Figure 2.1), dividing it into three distinct climatic regions: the *Sierra* or mountainous region, which is characterised by snow-covered peaks and high valleys; the eastern region, which is part of the Amazon basin; and the coastal region, which is influenced by the Pacific Ocean. With an estimated volume of 43,500 m^3 of water per person per year, the total rainfall per person in Ecuador is three times the world average of 10,800 m^3 (CNRH, 2002). However, this figure can be misleading as the water resources are not distributed evenly – either over the year, geographically, or throughout the population.

Figure 2.1 Physical map of Ecuador



Source: www.ciudadfutura.com/ecuador/fisico.com

Large areas of the country are subject to extreme climatic conditions, such as very dry summers and excessive rains in the rainy season. Floods are a common threat in some areas of Ecuador. In the coastal region, for example, the hot *El Niño* current from the north meets the cold Humboldt current from the south, producing severe climatic conditions which can cause huge damage. In 1997-1998, *El Niño* produced flood damage of around 2.9 billion dollars, and this is considered to be one of the main reasons for the country's latest political and economic crisis.

A large proportion of the population does not have access to safe and reliable drinking water sources. Only 67 per cent of Ecuador's 13 million inhabitants, have access to drinking water, and these are predominantly in urban areas (CNRH, 2002). But this national average disguises the fact that there are areas where there is very low coverage, such as the coastal region where only 20 per cent of the population has access to water. Furthermore, the majority of the drinking water systems have serious operational and maintenance faults, such as inadequately funded installations, unaccounted-for water loss, shortage of water meters, poor water quality, erratic service, and low pressure (Lloret, 2002).

Irrigation activities account for most of the water consumption (82 per cent). Yet only 7 per cent (approximately 600,000 hectares) of the area under cultivation is irrigated. Eighty per cent of the irrigation systems are community- or privately-owned, and the remainder are public. Water losses are above 50 per cent (Andrade and Olazaval, 2002). Industrial demand is increasing and as the water sources close to populated areas are depleted, conflicts with agricultural uses occur (Lloret, 2002). Thus, given the country's dependency on agriculture, as the country becomes more urbanised conflicts over water will become more serious.

Finally, there is growing recognition that water quality is deteriorating. The majority of the country's rivers are polluted by domestic and industrial wastewater, and agricultural runoff. Only Cuenca, the third largest city in the country, has a treatment plant, and this only treats 9 per cent of the city's wastewater. In general, industrial wastes go untreated, although in some areas environmental regulations have recently been strengthened. The poor water quality is illustrated by the fact that during the worst cholera epidemic in the region in 1991 and 1992, Ecuador was second only to Peru in the number of cases registered. According to the Health Ministry a large percentage of genetic defects in newborn children can be attributed to chemical water pollution (Lloret, 2002), caused by agricultural runoff and industrial wastewater discharges.

2.2 Complexities and contradictions within the water regime

As in most Latin American countries, water is a public good, with a few exceptions made for certain indigenous communities with ancestral rights. The Agrarian Development Law of 1997 upholds the principle that water is a national good for public use and as such cannot be taken away (Article 45). The *right to use* can be formalised and registered in the property but it is clear that it does not mean ownership:

> "In short, the waters within Ecuadorian territory have one sole owner - the State - which grants individuals the right to use only" (Arias, 2002, p.3).

The Water Law of 1972 establishes a hierarchy of uses: a) provision for communities and wells; b) agriculture and cattle raising; c) energy, industry and mining; d) others (Article 34).

Box 2.1 Main water laws and regulations in Ecuador

1960 Irrigation and Soil Sanitation Law regulates irrigation systems.

1966 Decree 1551 creates the Ecuadorian Institute for Water Resources (Instituto Ecuatoriano de Recursos Hidráulicos - INERHI).

1971 Special Decree 188 (also known as the Health Code) regulates water services for human consumption.

1972 Water Law on the management of all marine, surface, ground and atmospheric waters in the country.

1973 Special Decree 40 regulates the 1972 law and establishes the responsibilities of the INERHI, composed of an Advisory Council and 13 Water Agencies, and defines its jurisdiction to cover the whole country.

1994 Special Decree 2224 on the centralised planning, administration and control functions in the National Water Resources Council (CNRH). It also includes decentralised implementation, operation and maintenance of irrigation systems and water infrastructure, water quality control and conservation of watersheds by regional development councils. It also authorises the transfer of irrigation systems to its consumers (UEP-PAT - Implementing Unit for Technical Assistance for Irrigation Projects.

1999 Environmental Management Law creates a decentralised environmental management system.

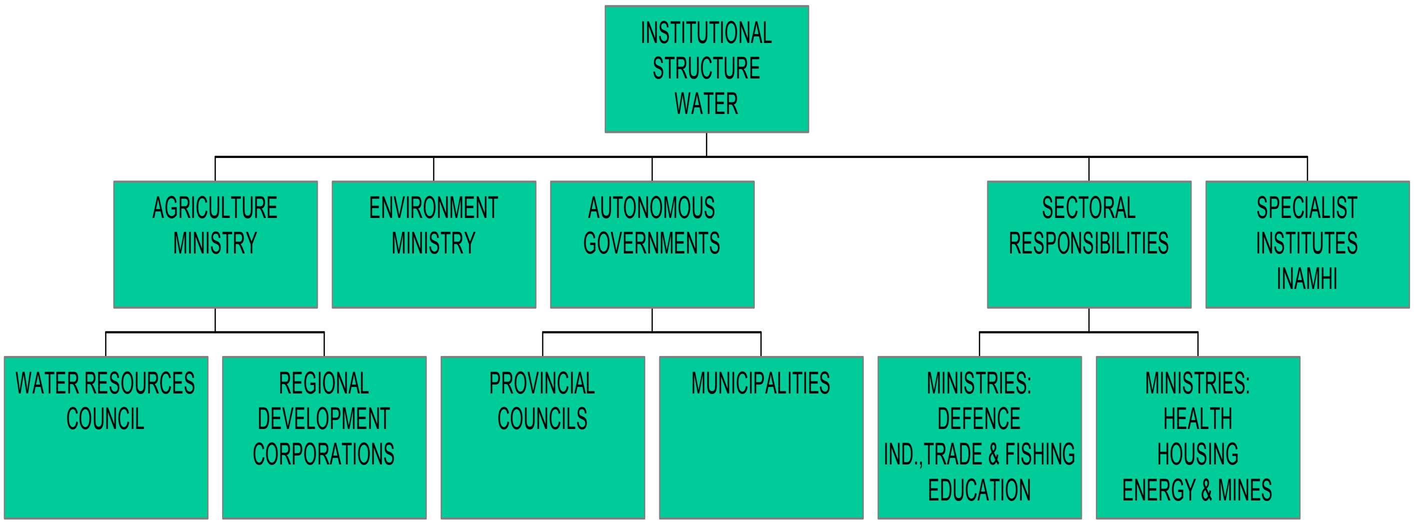
The institutional structure pertaining to water resources is complex and confusing, because of the multiplicity of institutions, regulations and jurisdictions involved. In a recent study a prominent environmental lawyer identified 25 laws and regulations as having direct relevance and 11 institutions as having direct or indirect jurisdiction over water resources (Arias, 2002). Box 2.1 simplifies the legal framework by highlighting the main laws and regulations. For example, provincial governments and regional development corporations have similar legal mandates with regard to watersheds and irrigation systems, yet they do not have a legal mandate to coordinate activities, nor do they attempt to prevent duplication of activities (Andrade y Olazaval, 2002).

The Special Decree 2224 of October 1994 attempted to modernise the 1972 Water Law by centralising planning, administration and control functions in the National Water Resources Council (CNRH). At the same time, implementation, operation and maintenance of irrigation systems and hydrological infrastructure, water quality and pollution control, and the conservation of watersheds were decentralised to nine regional development corporations (CORSINOR in the Northern Sierra; CORSICEN in the Central Sierra; CODELORO in El Oro Province; CODERECH in Chimborazo Province; CODERECO in Cotopaxi Province; CEDEGE in the Guayas watershed; CRM in Manabí Province; CREA and PREDESUR in the central and southern part of the country). Inspired by similar experiences being developed throughout Latin America, these regional development corporations were considered “motors of progress” that would build irrigation systems and thus modernise agricultural systems. They receive funding from the central government but the governing bodies are composed of national and regional representatives.

These corporations differ in terms of their jurisdiction, institutional structure, political power and resources, and have had differing degrees of success. Yet, their common focus has mainly been irrigation systems. They tend to work in isolation with few links to local and national decision-making processes.

This already confusing and dispersed system is exacerbated when we add to it interaction with the environmental authorities. The Environmental Law of 1999, which aims to strengthen the country's environmental management, created a decentralised environmental management system. This "system" is composed of all the institutions that have environmental jurisdiction, which includes ministries, municipalities and provinces. However, the latter two entities are legally defined in the Constitution as autonomous - Art. 228 (Llaguno, 2002 p.7-8). The challenge is how to coordinate these two, at times, overlapping bodies.

Figure 2.2 The institutional structure for water



Thus, as illustrated by Figure 2.2, water has been managed and administered on a sector-by-sector basis with no unity of focus towards integrated water resources management, but with a duplication of responsibilities. For example, water quality is a responsibility of the Water Resources Council but also of many other sectoral institutions: the Ministry of Agriculture for agricultural wastewater, environmental agencies for industrial discharge, the Ministry of Energy and Mines for hydrocarbon pollution. Although there are national water quality standards, their enforcement has been the responsibility of the municipalities since they are responsible for provision of drinking water.

The management and administration of water resources correspond to the geopolitical distribution of municipalities and provinces, which is not necessarily the most effective way to manage the resource. Watersheds are not used as management or planning units, although in theory their importance is recognised. Watersheds are the responsibility of the provincial governments, the forest service within the Ministry of Agriculture, and the regional development corporations. The constitution states that the provincial councils "must promote and carry out work within the provinces on roads, environment, irrigation and management of watersheds and sub-watersheds" (Article 228). Yet, in practice few activities are implemented at ministerial or provincial level and there is little or no coordination with the development corporations or municipalities to address watershed issues.

Regulations to enforce the 1972 Water Law establish that water tariffs are to be paid to the Council and that the tariff structure should be reviewed every three years. Drinking water and hydroelectricity are exempt from tariffs. Although the current irrigation tariffs are very low (just over \$1.0 per hectare) few users actually pay (CNRH, 2002). The income does not cover the needs of the irrigation systems, let alone the administration of the resource. Most municipal water companies are in financial difficulty because of poor management and lack of funding from central government. Attempts have been made to reduce subsidies and move towards transparent pricing. However, there are arbitrary regulations that are deeply entrenched in the system, such as the 50 per cent discount for low level industrial use and for social and educational institutions.

Consumer participation is limited within the framework of the 1972 Water Law. Rather, the government regulates water use and does not make provision for consumers to participate in the decision-making process. The 1994 decree authorised the transfer of irrigation systems to its users as a national policy implemented through a department of the Ministry of Agriculture (Executive Unit for Technical Assistance on Irrigation Projects - UEP-PAT) funded by World Bank. Although this process is now underway and could empower consumers, experts consider that the transfer has been carried out in an ad-hoc fashion, without the necessary training and capacity building to ensure the long-term viability of the system (Andrade y Olazaval, 2002).

2.3 Watershed management: an unfulfilled goal

Watershed management has been a goal for many years, but results have been limited. One good example of watershed management is that of the Paute River watershed, which is important because it provides almost all of the country's electricity (Proyecto Plan Maestro para la Protección de la Biodiversidad Mediante el Fortalecimiento del SNAP, 1998). A more recent experience is the Carchi Consortium, which integrates private and public organisations from all sectors of society, using the "sub-watershed eco-region" of El Angel in northern Ecuador as its planning unit. The Carchi Consortium takes a holistic approach in which water is the focus for the management of the area.

Although, in theory, there is a recognition of the importance of watershed management, there are few programmes, and most of those that do exist are developed through international cooperation and with short-term funding. According to Pablo Lloret, a water resources administrator "the majority of watershed experiences are linked to integrated watershed management studies, which generate a long list of projects, or to the construction phase of hydrological or other infrastructural works. They are sponsored by commissions or development corporations or by large water users, such as hydroenergy, irrigation and drinking water projects" (Lloret, 2002).

Unfortunately, there has been little continuity in the development of watershed programmes and little or no systematisation of the results.

Yet there have been increasing calls for a more integrated management of this vital resource. National environmental policies point to water resources as a key area for development and describe the state's role in defining the legal and institutional framework for integrated water management based on watersheds with the participation of local governments and communities (Políticas Básicas de la Estrategia Ambiental de Desarrollo Sostenible, 1999). At the time of writing, four different proposals were being discussed in Congress for reform of current water law and in these proposals watersheds are the geographical units around which management and administration of the resource are based. All of the proposals aim to establish a sound tariff structure, clear regulations for water use and concessions, control of wastewater discharge and protection of watersheds. The political sensitivity of water and the spectrum of ideological positions make it unlikely that a reform will be approved. The indigenous communities are very fearful of water privatisation, and multilateral agencies and commercial agricultural interests want to promote investment in irrigation systems and infrastructure development.

The Water Resources Council's proposal for the reorganisation of the water sector has been under discussion over the last year. It proposes the creation of nine watershed management units, each of which has a water administration authority or agency, to administer water use rights, develop management plans and monitor water quality. Each unit would also have a watershed council, which would include the active participation of the water users (CNRH, 2002). Unfortunately, this proposal does not seem to be on the current political agenda, and its implementation seems remote. The Council does not have the political leadership or influence to turn this debate among specialists into a national debate.

To add to this pessimistic panorama, there is growing public concern about the long-term sustainability of forests and in particular their ability to provide hydrological "services", such as maintaining quality and flow.

Although the 1981 Forestry Law prohibits the conversion of forests to other uses, forests are disappearing at an alarming rate. Different institutions present various statistics for deforestation, and there is no agreement as to the precise figure. However, the magnitude of the figures indicates the seriousness of the problem. Ecuador has the second highest deforestation rate in South America, estimated by FAO to be 1.6 per cent per year, which is higher than the world average for tropical biomes, which includes highlands, montane and lowland forests (Bruijzneel, 2001).

A recent study on the economics of deforestation in Ecuador considers the following to be the principal causes of deforestation (Wunder, 2000):

- the role of logging companies
- the fuelwood trap
- poverty and forest loss
- the impact of population growth
- land tenure and access
- extra-sectoral (non-forestry) policies

Wunder characterises the deforestation cycle in Ecuador as follows:

- *Phase 1:* timber and charcoal extraction (1-2 years).
- *Phase 2:* slash-and-burn agriculture (2-5 years):
  - potatoes, beans (1-2 years)
  - maize (1-2 years)
  - wheat, barley (1-2 years)
- *Phase 3:* pasture for cattle ranching (7-10 years)
- *Phase 4:* fallow and bushland regeneration (1-5 years)
- *Phase 5:* slash-and-burn, agriculture, pasture, etc.

The scientific debate about the hydrological implications of deforestation is complex and at times counter-intuitive. Nevertheless, it is generally accepted that replacement of montane forests, particularly cloud forests, with agriculture and pasture, with little or no management, can reduce the stability of the soil, its capacity for infiltration and, in the case of cloud forests, interception of horizontal and net precipitation, thereby reducing water flow during the dry season (Bruijzneel 2001). Changes in forest cover might not affect local rainfall, but as mentioned by Bruce Aylward in his electronic newsletter, 'scientists are agreed that the loss of forest will adversely affect rainfall in vast continental basins (such as the Amazon basin, which is partially enclosed) and in cloud forest areas (due to loss of horizontal precipitation or fog drip)" (Flows, 2002). In a recent study in Costa Rica, Lawton et al. (2001) found that deforestation in lowlands could reduce cloud formation and increase cloud elevation during the dry season in higher altitudes, and thus reduce precipitation in cloud forests. The foregoing relates mainly to cloud forests, which are important in Ecuador, and in particular the case of Pimampiro as highlighted in section 3. Unfortunately, there are no hydrological studies from Ecuador that the authors were able to draw on, nor studies linking forests to water quality.

The main source of water for the country's population is the *páramo,* or high altitude grasslands. Unfortunately, there are no estimates for the percentage of useable water that comes from these ecosystems but it is clear that the majority of the country depends on the páramo for their water since the Andes provide the drainage for the whole country. The high humidity and low temperatures limit evaporation and decomposition of organic matter. Large volumes of water come from melting glaciers and snowfalls, abundant rainfall (>3,000 mm per year) and almost constant horizontal precipitation. All this humidity is stored in the organic soils and the vegetation which absorbs water like a sponge (Hofstede, 1997). Robert Hofstede, an expert on this type of ecosystem estimates that in the rainy season, the páramo soils contain between 1,000 and 6,000 cubic metres of water per hectare. About half of this volume is mobile.

Although the páramo only covers 5 per cent of the country's surface, it is of great social, economic and cultural importance because a large proportion of the country's population and economic activity depends upon it. The páramo is under threat from a variety of human activities, including burning, grazing, crop cultivation, reforestation with exotic species, and, to a lesser extent, plant, wood and soil extraction, hunting, and tourism (Hofstede, 2001). The páramo is protected by the state and is considered under the Environmental Management Law to be a "fragile ecosystem". As such, forestry regulations and sanctions can be enforced. Additionally, there is a special regulation which clarifies the legal status and the conservation of this ecosystem (Morales, 2001).

Ecuadorian public opinion holds that forests and páramos generate water. Although this assertion could be very useful for conservation efforts, it is a gross oversimplification; further scientific studies on this theme are required. Furthermore, it has not managed to change attitudes or ensure the protection of these ecosystems. In general, legal enforcement in the country is poor and even more so in the case of environmental laws. This situation is further exacerbated by the corruption that is rife in Ecuador.

2.4 Promoting payments for environmental services

Various national, local, public and private organisations interested in improving natural resource management are advocating the valuation of the services provided by ecosystems. The Ministry of Environment and many environmental organisations are interested in valuing watershed services. National environmental policies (Basic Policies for the Environmental Strategy for Sustainable Development) define the protection of water resources and the valuation of water as key responsibilities of the Ecuadorian State.

Ecuador's second Strategy for Sustainable Forest Development relates to the valuation of native forests and plantations. The strategy aims to:

"Create and promote the legal basis and mechanisms to allow the payment for environmental services provided by forests, so that their owners will receive a monthly payment in cash for the services they render. Society demands, among other things, the protection of soils and other infrastructure, regulation of water quality and quantity, protection of the biodiversity and maintenance of the scenic beauty provided by forests. However, in Ecuador, the mechanisms to internalise the cost of these services, and directly compensate the owners of these forests, have not yet been created".

Ecuador's National Biodiversity Policy considers markets for environmental services within Ecuador's ecosystems as a means of protecting these ecosystems (Ministerio del Ambiente, 2000), and thus the strategy recommends establishment of the following:

- a payment system for the protection of mountainsides, provision of water from forests and páramo, and protection of coasts;
- payment for environmental services on public and private lands (including in the National Protected Areas System), for the provision of water for hydroelectric plants, irrigation and human use; erosion control and global climate change services (for example carbon sequestration);
- an adequate compensation system to landowners, whether individuals or communities, for the lands that generate the services;

- investment in the protection and maintenance of lands in order to ensure the continuity and quality of the environmental service;
- investment in the social development of the communities within or around the lands in question (Llaguno, 2002 p.2).

The biodiversity policy explicitly defines páramo*s,* mangroves, flood plains and forests on hillsides as the priority ecosystems for the development of these market mechanisms.

In addition to declaring environmental services as a political aim, the Ministry of Environment is attempting to institutionalise them. Thus, a corporation (CORDELIM) was created to promote and market Ecuadorian climate change mitigation projects, to be presented to the Clean Development Mechanism created by the Kyoto Protocol. The creation of a biodiversity corporation (BioE) has also been proposed and is currently under discussion. A consultancy was recently contracted to define the institutional structure required to institutionalise environmental services. No decisions have yet been made; the policy documents define environmental services vaguely and do not clearly explain the way in which water, forestry and environmental regulations could be harmonised.

Despite the lack of clarity, local initiatives are being implemented at municipal level aiming to compensate landowners for the protection of water sources. As part of this project, the project team undertook a national review and identified seven initiatives in the country that implicitly and explicitly recognise the water quality and quantity benefits provided by forests and páramos.

Before evaluating and analysing these initiatives, a basic flaw must be highlighted. As Vogel (2002) explains, paying private landowners for the water services provided by their forests contradicts current legislation. Landowners are not permitted to deforest their land, and they do not own the water that flows from their property. They cannot sell something they do not control or own. Thus, in developing payments for environmental services in Ecuador, there is a need to clarify exactly what is being bought and sold in order not to subvert the current environmental laws and further weaken the credibility of the water regime. Legislation needs to be amended to make it more coherent.

Notwithstanding the legal issues above, the fact remains that payments for watershed services are emerging. It is therefore crucial that we understand the dynamics of these systems (e.g. the drivers and how they have arisen) and their impacts, so that we can formulate appropriate responses. To evaluate and analyse the socio-economic impacts of the payments, the project team selected Pimampiro and Cuenca. Although they are in the early stages, these cases can provide lessons about how the system of direct payments can work. The following two Sections (3 and 4) describe these two cases and how they came about, and outline the key findings relating to the drivers and their impacts.

3. Pimampiro: paying landowners to protect the forest

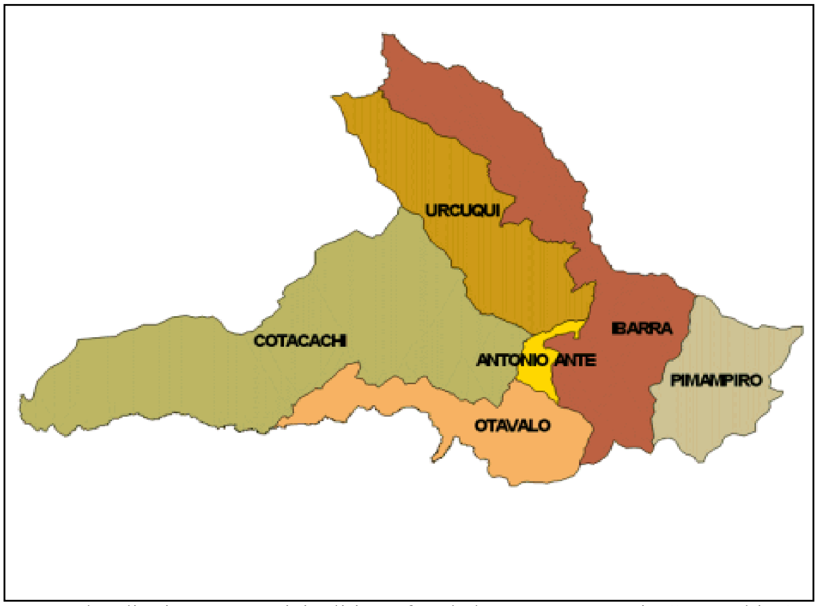
3.1 Location

San Pedro de Pimampiro is a municipality located in the north-eastern corner of the Imbabura province in Ecuador's Andean region (Figure 3.1). The province of Imbabura has an area of 4,560 km² and is located in the valley of the Chota River. The province is divided into six municipalities (Figure 3.2). The main economic sectors in the province are agricultural; principally dairy and livestock production, and bean, banana, corn and coffee cultivation.

Figure 3.1 Political map of Ecuador

Source: www.comunidadandina.org/quienes/map_ecu.htm

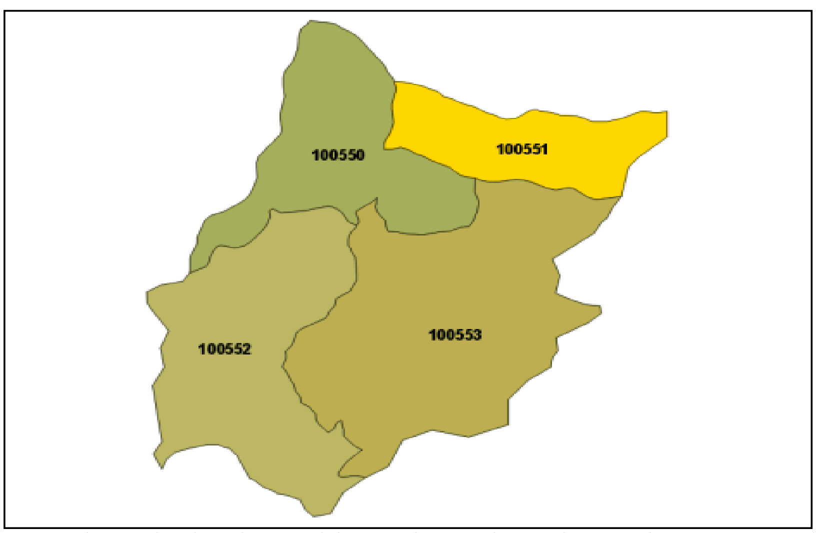
Figure 3.2 Political map of Imbabura



Note: The districts or municipalities of Imbabura are: Uruqui, Cotacachi, Otavalo, Antonio Ante, Ibarra and Pimampiro.
Source: www.ame.org.ec

The municipality of Pimampiro has four parishes: Pimampiro, Mariano Acosta, Chugá and San Francisco (Figure 3.3), and has a population of 17,285 (6,311 inhabitants reside in the urban zone while 10,974 live in the rural zone) (Municipalities of Ecuador, 2002). The municipality has a density of 39 people per km², ranging from 12 in the town of Pimampiro to 100 in San Francisco de Sigsipamba . The population has remained stable, with a growth rate of 0.17 per cent between 1982 and 1990 (EcoCiencia, 2002).

Figure 3.3 Political map of Pimampiro



Note: Pimampiro has four parishes: Chuga, Pimampiro, Mariano Acosta and San Francisco de Sigsipamba.
Source: www.ame.org.ec.

3.2 Water supply

3.2.1 Water quantity and quality

The municipality is subject to water shortages. Until 2001, domestic water users received a water service two days a week, for a period of two hours per day (CEDERENA, 2002). A quarter of the population had limited access to drinking water services (Guerrero, 2002). Water quality is also a problem as the water is affected by agriculture upstream. However, the main concern is still access, and for this reason, developing the appropriate infrastructure for increasing water flow has been a priority.

3.2.2 Vegetal cover

Pimampiro is located in the highlands at an altitude of between 1,600 and 4,000 metres above sea level. Owing to the altitudinal range, the area has four types of vegetation: lowland evergreen montane forest, cloud forest, highland evergreen montane forest, and herbaceous grassland or páramo (Sierra, 1999).

The evergreen lowland montane forest[1] covers the lowest part of Pimampiro. This forest is located between 1,300 and 1,800 metres above sea level and it extends from Colombia to the Girón-Paute valley. The highest trees in the forest reach 30 metres. In this montane forest most of the lowland tree species such as the Bombacaceae family are no longer found (Sierra, 1999).

Montane cloud forests extend from 1,800 to 3,000 metres above seal level. The tallest trees of the forest reach 25 metres and most of the trees are covered by moss. Epiphytes such as orchids, ferns and bromeliads are predominant. There is also a variety of bamboo plants in the cloud forest (Sierra, 1999).

The evergreen highland montane forest[2] of the western Andes extends from 3,000 to 3,400 metres above sea level. It contains the “Ceja Andina”, which is in transition between highland montane forest and páramo. As in the montane forest, moss and epiphytes are present in the cloud forest. However, in the montane forest a dense layer of moss covers the soil and the trees grow irregularly. The trunks form branches from the base of the trees. The trees grow in a tilted, almost horizontal fashion (Sierra, 1999).

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[1] The characteristic flora of lowland evergreen montane forest are: *Anthurium ovatifolium, Anthurium spp.* (Araceae); *Ceroxylon alpinum, Socratea exhorriza* (Arecaceae); *Buddleja americana* (Budlejaceae); *Cecropia bullata, Cecropia monostachya* and *Cecropia spp*. (Cecropiaceae); *Cyathea spp* (Cyatheaceae); *Heliconia spp* (Heliconiaceae); *Hectandra membranacea* (Lauraceae); *Carapa guianensis* (Meliaceae); *Siparuna guajalitensis, Siparuna eggersii, Siparuna laurifolia, Siparuna spp.* (Monimiaceae); *Fuchsia macrostigma* (Onagraceae); *Piper spp* (Piperaceae); epiphyte species of *Ficus spp*. (Moraceae) (Sierra, 1999 pp. 82,83).

[2] The characteristic flora of the evergreen highland forest is: “*Gynoxys buxifolia* and *G. spp* (Asteraceae); *Berberis conferta* (Berberidaceae); *Tournefortia fulicinosa* (Boraginaceae); *Hedyosmum spp.* (Chloranthaceae); *Gunnera pilosa* (Gunneraceae); *Brachyotum ledifolium* (Melastomataceae); *Siphocampylus giganteus* (Campanulaceae); *Vallea stipularis* (Elaeocarpaceae); *Siparuna echinata* (Monimiaceae); *Myrcianthes rhopaloides* and *M. spp.* (Myrtaceae); *Piper spp.* (Piperaceae), *Hesperomeles lanuginosa* (Rosaceae); *Cervantesia tomentosa* (Santalaceae); *Freziera verrucosa, F. canescens y F. spp* (Theaceae). At higher altitudes, in the “Ceja Andina” (according to Diels 1937) shrubs are more common (for example, *Hypericum laricifolium*, *Brachyotum ledifolium*, *Lupinus spp.*), but there is an occasional presence of *Buddleja incana* (Budlejaceae), and *Miconia spp.* (Melastomataceae), and other species” (Sierra, 1999 pp.85).

All of these cloud and montane forests are part of the tropical montane cloud forest, and are characterised by the presence of clouds, low temperatures and humidity, which are important factors with regard to hydrological functions, in particular, increased surface runoff during the dry season, as discussed in Section 1.

The herbaceous páramo[3] is located between 3,400 and 4,000 metres above sea level. In its lower part lies the "Ceja Andina" and deforested fields for crop cultivation. The plants that dominate the páramo have crests and plumes, such as those of the genus *Calamagrostis* and *Festuca*. These plants are interspersed with small shrubs and other vegetation. Some species grow only in the páramo of the northern Andes, such as *Calamagrostis effusa* (Sierra 1999).

3.2.3 Hydrology

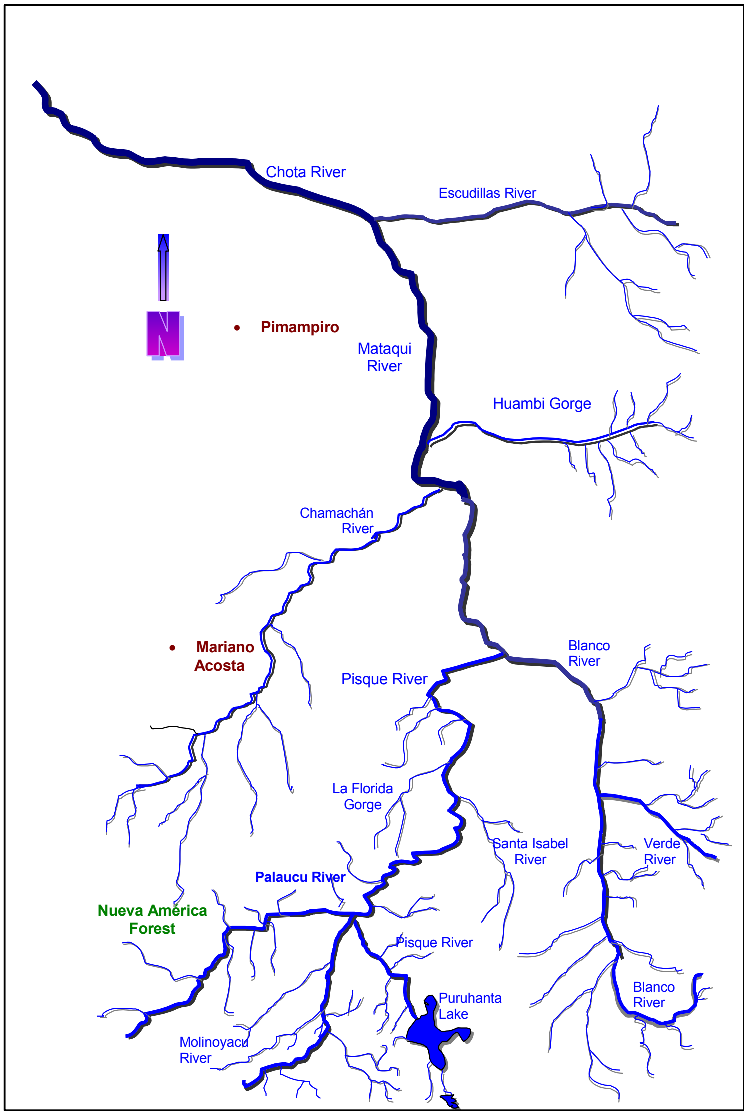
One of the largest rivers in the province of Imbabura is the Chota. This river forms the northern boundary between the province of Imbabura and the northern province of Carchi. It changes its name to river Mira when it passes Ibarra, the capital of Imbabura, and flows into the Pacific Ocean in Colombia. The Chota has four tributaries: the Escudillas, the Chamachán, the Blanco and the Pisque. The Pisque, in turn, has three tributaries: the Palaurco (also known as the Palaucu), the Molinoyacu and the Pisque (Figure3.4).

The town of Pimampiro is located on the river Pisque watershed, specifically in the Palaurco sub-watershed. Water from the Palaurco is used for irrigation and consumption in Pimampiro. The headwaters are in the Páramos de Angococha (IGM, 1990). Annual precipitation in the area is estimated to be 850 mm per year (Lascano, 2002).

Despite the lack of hydrological information, the common perception is that the forests ensure water supply, particularly during the dry season, and water quality, since the trees can prevent erosion.

[3] The characteristic flora of the páramo are: *Calamagrostis effusa, C. spp., Festuca spp*. (Poaceae); *Hypochaeris spp., Baccharis spp, Chuquiragua jussieui, Oritrophium peruvianum* (Asteraceae); *Gentiana sedifolia, Gentianella selaginifolia, G. cerastioides, Halenia spp.* (Gentianaceae); *Geranium sericeum, G. ecuadorense* (Geraniaceae); *Huperzia talpiphila* (Lycopodiaceae); *Lupinus smithianus, Lupinus spp*. (Fabaceae*); Ranunculus guzmanii, Ranunculus spp.* (Ranunculaceae); *Castilleja spp*. (Scrophulariaceae); *Valeriana rigida y V. spp* (Valerianaceae)" (Sierra 1999 pp.87).

Figure 3.4 Map of the Chota (or Mira) watershed



Notes: Chota River has four main tributaries: Escudillas, Chamachan, Pisque and Blanco. Data is not to scale. (Fernanda Meneses 2002).

3.2.4 The sellers: Nueva América Association

The Nueva América Autonomous Association for Agriculture and Livestock is located 32 kilometres south of the city of Pimampiro upstream, in the parish of Mariano Acosta and within the Palaurco watershed. It was created in 1985 with the aim of formalising the group's tenure of 502 hectares of land (Cayambe, July 2002). Between 1989 and 1997, the Association paid for a total of 638 hectares.[4] In 1991 the Ministry of Agriculture built the road that allows access to the Association's lands. The Association was originally formed of 40 members but some of them sold the land to other members of the association. At present the Nueva América Association has 24 members, of whom 20 are receiving payments for environmental services. All the members have individual title to their land. According to the

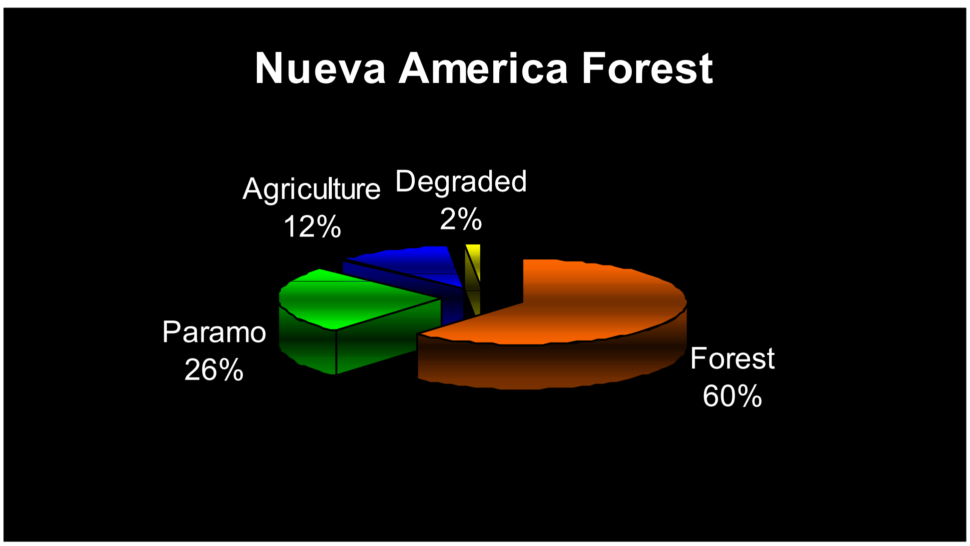
[4] These are approximate figures since there are discrepancies between the property titles, Cederena's evaluation and the national land institution (INDA).

11 members consulted, the size of properties varies from 12 to 119 hectares, with an average of 43 hectares per member.

Most of the members of the Association describe themselves as "colonos" which means that they have recently settled in that area. They are mestizos of Indian descent. There is an average of six children per family. Only four families of the Association live permanently in the forest, while the rest live in different settlements in the lowlands (such as Rumipamba and Mariano Acosta). The Association's land has no electricity supply or sewerage service, and drinking water is collected from a nearby stream. The children attend school in the nearby Mariano Acosta parish. The main source of energy for cooking is fuelwood.

The main economic activities of the families are agriculture and livestock production. Other sources of income are animal raising, wood extraction, and planting and harvesting crops on lowland farms. The latter activity pays US$2 to US$3 per day per person (Cayambe, 2002). Young adults work in larger cities like Ibarra or Quito (the capital of Ecuador), to help their families in Pimampiro. Most of the men in the Association completed third grade of school, while 30 per cent of the adult women are illiterate (CEDERENA, 2002).

Figure 3.5 Forest area in Nueva America



Notes: Nueva America owns 638 hectares, of which 60 per cent is forest, 26 per cent is páramo, 12 per cent is land for agriculture and 2 per cent is degraded land.
Source: CEDERENA 2002.

Of the 638 hectares the Nueva América Association owns, 390 hectares are forest, 163.3 hectares are páramo, 74.9 hectares are dedicated to agriculture and livestock, and the remaining 9.8 hectares are degraded land (3.5) (CEDERENA, 2002). The areas dedicated to agriculture and livestock have potato, beans and pasture crops and to a lesser extent local Andean vegetables (*melloco and ocas)* (CEDERENA, 2002). It is important to note that the community bought the land as a unit, and over time it has opened it up for agricultural production, moving from a communal title to individual plots.

Figure 3.6 Upper parts of the watershed: Nueva América

Photo: Ina T Porras

The forest is located in the buffer zone of the Cayambe Coca Ecological Reserve (RECAY), between 2,900 and 3,950 metres above sea level (CEDERENA, 2002). As mentioned previously, the forest is composed of páramo and evergreen montane forest. Forty-three per cent of the area is primary forest[5] and the remaining 57 per cent of the area is secondary forest, as the presence of the bamboo species "surro'' of the genus *Chusquea* indicates (CEDERENA. 2002). A part of this secondary forest has not been touched for approximately ten years.[6]

The Nueva America forest contains "sigse" *(Cortaderia nitida),* "surros" *(Chusquea* spp.*)* and Rosaceae (*Lachemilla orbiculata)*. The first two species are good indicators of water presence, and the third one grows in areas that have been under intensive pasture (Mena Vasconez and Medina, 2001). This indicates that even though the area has been affected by human activities, the forest still maintains its capacity to retain water.

The páramo appeared to have been well conserved. Three different genus of grasses or "paja", *Stipa*, *Calamagrostris* and *Festuca* predominate. The existence of certain species of flora and fauna, like the Andean or spectacled bear (*Tremarctos ornatus)* reflect the good

[5] Primary forest is characterized by tree species like "matache" (*Weimania pinnata*), "amarillo" (*Miconia sp*), "manzano" (*Rannhus sp*), "borracho" (*Hedyosmum sp*), "tupial" (*Myrsine dependenz*), "hoja blanca" (*Polymnia pyramidalis*), "puchinche" (*Cletra fimbriata*), "pumamaqui" (*Oreopanax sp*) and "aliso" (*Alnus acuminata*). The forest also has bromeliads, lichens, orchids and ferns (CEDERENA 2002).

[6] Secondary forest has tree species like "aliso" (*Alnus acuminata*) and "hoja blanca" (*Polymnia pyramidalis)*. The younger secondary forest has not been touched for about four years and has plant species like "hoja blanca" (*Polymnia pyramidalis*), "motilon", "cola de caballo" and "ortiga".

condition of the land. Other páramo plants are “echol” (*Gaiadendrum punctatum*) and “piñuela” (*Puya sp*). Access to this area is difficult and this is one of the reasons for the limited human presence in the area.

There are also areas of steep escarpments containing small, dense forest surrounded by tall coarse grass. Years ago, this páramo was forest, but the use of slash-and-burn practices for agricultural production transformed the original vegetation. This is why small patches of forest can be seen in the grasslands of Nueva América. These remnants of the original forest on the high slopes are viable for conservation since they are not suitable for pasture or agriculture.

This area has faced strong deforestation pressure for timber extraction, agriculture and cattle raising. The construction of a highway ten years ago also increased the rate of deforestation by facilitating the transportation of timber (CEDERENA, 2002). In 1985, Pimampiro had 19,000 hectares of primary forest. Today there are less than 7,000 hectares (Municipalidad de Pimampiro, 2002). However, there is no agreement as to the accuracy of these figures. According to a CEDERENA employee, around 40 hectares have been deforested within a monitored area of 550 hectares since 1986 (Silvia Ortega, 21 November 2002). This implies a lower rate of deforestation than that mentioned above. In general, the hydrological impacts anticipated because of land use change have not been measured or studied.

3.3 Water demand

The two main water consumers in the area are households, for domestic use, and farmers, for irrigation.

3.3.1 Drinking water

The Pimampiro water treatment plant started functioning in April 2001, funded by a loan from the State Bank. Before the plant came into existence, Pimampiro obtained its water from the Puetaquí canal, which is part of the Chamachán sub-watershed. This water was not treated, except for the addition of chlorine. Consequently, the service was deficient both in quantity (only two hours of water supply, twice a week) and in quality (the manual chlorination system). There are no statistics to illustrate these conditions.

The new plant is located 7 km from the town and has the capacity to treat 50 litres per second (l/s). Currently, the plant operates at 24 per cent of capacity, with an average flow of 12 litres per second. The two main sources of water for the plant are the Puetaqui stream (4 l/s) and the Del Pueblo irrigation canal (8 l/s), which comes from the Chamachán, a neighbouring watershed to the Pisque.

To fully satisfy the town’s demand the system must increase flow to 20 l/s (Paspuel, 2002). No information on the distribution of the service was found.

A new 1 km tunnel which is being built (Nueva America Project) will add 60 l/s to the system, 20 l/s for the town of Pimampiro and the remaining 40 l/s for irrigation. This tunnel was due to be completed in 2003 and was funded by the provincial government.

3.3.2 Irrigation

Approximately 500 hectares are being irrigated from Del Pueblo[7] canal, is a 16-kilometre ditch which was built in colonial times. The water comes from a small stream called Tigre Rumi at an altitude of 3,030 metres in the parish of Mariano Acosta. There is a flow of 140 l/s which supplies water to the 375 families that hold water concessions granted by the water agency. The biggest consumer is Hacienda Jesús Miranda, which has an area of 400 hectares and has 25 per cent of the concessions, then after diverting to the city's water treatment plant, the farms in the lower part of the canal in Pimampiro, which hold 50 per cent of the concessions, are irrigated, followed by Santa Rosa, which holds 25 per cent of the concessions. It is estimated that the potential area to be irrigated is 1,500 hectares, which would require an additional flow of 248 l/s. The maximum capacity of the canal is 400 l/s (Lascano, 2002).

3.3.3 The buyers: the residents of Pimampiro

The city of Pimampiro consumes 12 l/s of water and 1,350 households have water meters (CEDERENA, 2002). The residential tariff was initially US$0.80 for 17 cubic metres of potable water (Paspuel, 2002). The tariff paid by industries or commercial establishments for the same volume of water was US$1.80. The tariffs were raised in 2001 to US$0.96 and US$2.16 respectively. Residents accepted the 20 per cent tariff increase because it coincided with the construction of the new plant, which improved the service considerably. Of the 36 people consulted, only six were not satisfied with the water service.

The total variable cost of water treatment in the plant, including labour costs, chemical agents and spare parts is US$0.21/m³ (Paspuel, 2002). Because of the system's inefficiency, only 60% of the water billed is collected, which means that the municipality is heavily subsidising the service. However, 35 of the 36 people consulted agreed that it was important to protect the watershed.

3.4 Linking supply and demand

3.4.1 The payment mechanism

This section describes the fund that was created to ensure that payments by domestic users are channelled to those people investing in the continued supply of water by maintaining forest cover.

The actors

This initiative has involved many actors, including:

- DFC, an FAO-funded project for community forest management,
- Cederena, an NGO which evolved from DFC

[7] The canal is managed by a board and the administrator has to establish an annual operating budget, on which the tariffs are based. It is interesting to note that the tariff is paid not by volume but by time. The current fee is US$3.80 per hour. There are sanctions ranging from US$0.50 to US$2.00 for unauthorized water collection. If a violation is repeated, the service can be cancelled indefinitely. As up to 50 per cent of the users are late in paying, the new rules establish that interest is to be charged or that the service is to be suspended until payment is made (Lascano 2002).

- The Inter-American Foundation, a US donor
- The municipality of Pimampiro

In 1994 DFC[8] worked with the Nueva América Association to develop a forest management plan for their land. The plan identified priority management activities such as agroforestry, soil management, selective exploitation and enrichment planting. In 1996 additional activities were established, such as commercial orchid cultivation, medicinal plant collection, soil conservation, environmental education, natural regeneration, and "aliso" (*Alnus acuminata)* management (CEDERENA, 2002). The development of a forest management plan helped the families of the Association obtain the titles to their land. From 1997 to 1999 DFC reduced their presence in the area, but continued its support to the municipality with the creation of UMAT (the Environment and Tourism Unit), which will be discussed later.

In 1997 several DFC technicians founded CEDERENA (the Ecological Corporation for the Development of Renewable Natural Resources) as a national non-profit organisation to facilitate community management of natural resources, local development, environmental services and institutional development (Yaguache, 2002). In 1999 CEDERENA continued with the work that DFC had started, opening offices where the DFC had worked in Quito, Ibarra, Pimampiro, Santo Domingo, Riobamba and Cuenca. The CEDERENA office in Pimampiro now has one coordinator, one administrator and four other employees. CEDERENA works on developing suitable forest management plans for the Nueva América Association and other communities.

The role of the municipality and the Environment and Tourism Unit

In accordance with Article 233 of the constitution Ecuador is undergoing an extensive decentralisation process (EcoCiencia and CEDA, 2001). A decentralisation and social participation law was passed in 1997 to promote local government action. It mandated municipalities to preserve and defend the environment by requiring environmental impact assessment studies and promoting local management of protected areas. This has made municipalities focus on environmental issues and develop the institutional and budgetary arrangements to do so.

The challenge that this legislation presented, coupled with the municipality's water shortage, led to the creation in 1998 of the Environment and Tourism Unit (UMAT) within the town's governance structure. The former mayor of Pimampiro, Edwin Lora, created the unit by ordinance (based on a study by DFC), in order to implement the municipality's

[8] The *Desarrollo Forestal Comunitario* (DFC) is a project within the Forest Action Plan for Ecuador (PAFE) implemented by the Food and Agriculture Organization (FAO). The DFC is part of the Participatory Forest Development Project in the Andes, started in 1989 with the aim of documenting social, economic, environmental and technological impacts of forestry experiences for communities in Bolivia, Colombia, Chile, Ecuador and Peru (DFC, 2002). In Ecuador, DFC has been working since 1993 in nine out of ten provinces in Ecuador's highlands. DFC has developed methodologies for natural resource management with a focus on participatory forest development, providing training and empowerment to indigenous communities and small farmers to carry out their own community forest plans (DFC 2002). The object is to improve the quality of life of the highland communities in Ecuador. In the province of Imbabura, DFC currently works with 20 small farming communities as part of a consortium of institutions. The institutions include CEDERENA, the municipality of Pimampiro, and the Red MACRENA (an NGO with a network of ex-DFC technicians for training in natural resources management), and they receive funding from the Inter-American Foundation (IAF), FAO and the Netherlands Government (Yaguache s/d).

environmental strategy. The strategy consists in an 11-point mandate covering four main programmes:

- pollution control activities
- environmental education
- ecotourism
- watershed management

UMAT is developing activities for watershed protection (including páramo and forest protection), irrigation and drinking water projects (Municipalidad de Pimampiro, 2001).

In 1999, CEDERENA signed an agreement with the municipality of Pimampiro to work on the project Sustainable Management of Pimampiro's Renewable Natural Resources for the Maintenance of Water Quantity and Quality. This project which was designed by CEDERENA and financed by the Inter-American Foundation (IAF)[9] (CEDERENA, 2002) and had two main objectives:

- natural resource conservation in Pimampiro
- strengthening Pimampiro's Environment and Tourism Unit (UMAT)

CEDERENA received \$US326,200 from IAF for three years to implement a project to counteract environmental degradation and to help 450 small farmers in the application of soil conservation, organic farming, watershed recovery and sustainable forest management techniques (Inter-American Foundation, 2002).

As part of this project, and in particular the forest management plan in Nueva América, the UMAT implemented an environmental payment system in order to create incentives for the people who conserve the forest, and to penalise those who do not (CEDERENA et al. 2001). With the participation of the municipality and CEDERENA, the Nueva América Association reorganised their management plan into five programmes, which included an Environmental Service Programme, which has four projects: 1) Maintenance of forest capacity to regulate water quality and quantity; 2) Carbon sequestration; 3) Ecotourism; and 4) Biodiversity protection (CEDERENA, 2002).

This payment system is considered a pilot experience and thus was only implemented for Nueva America. However, DFC and CEDERENA have worked in other areas that could be potential beneficiaries of the payment mechanism.

The City Ordinance and creation of the fund

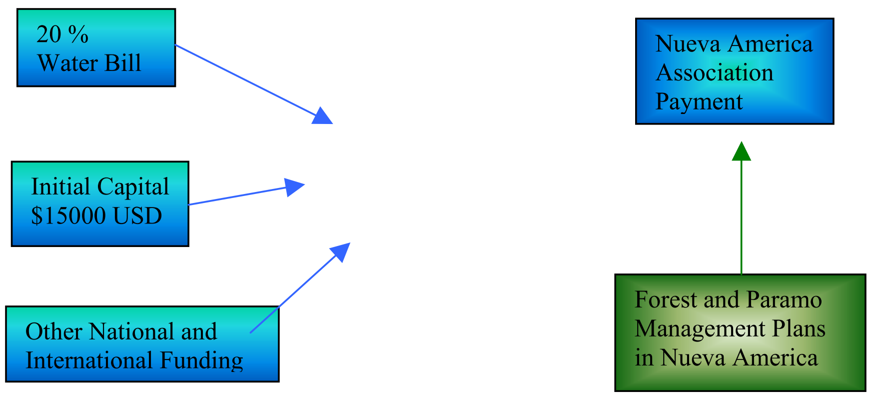
The municipality of San Pedro de Pimampiro considered the forest and páramo ecosystems of Nueva América important for the maintenance of water quality and quantity, and thus began the pilot experience. In the beginning of 2001, the municipality approved a new ordinance[10],

[9] The Inter-American Foundation is a United States Government foreign assistance agency. It works to promote equitable, responsive and participatory self-help development in Latin America and the Caribbean (Inter-American Foundation 2002).

[10] The ordinance by which the fund was established has 13 articles and covers the following issues: an introduction, the activities and rationale for the creation the fund, fund financing and management, ecosystem categories, payment candidates, and sanctions.

which established a Water Regulation for the Payment of Environmental Services for Forest and Páramo Conservation (CEDERENA, 2001). This became part of the UMAT's responsibilities.

Figure 3.7 Financing and payments of the fund



Source: CEDERENA 2002

The fund was created with an initial investment of US$15,000, of which US$10,000 came from the IAF (via CEDERENA) and the remaining US$5,000 came from the DFC Project. The fund also receives the 20 per cent increase on the drinking water tariff, which was calculated to amount to US$500 a month (Figure 3.7). The resources are managed in an account with the National Development Bank. Given that only 60% of the water billed is actually paid for, the municipality does not always manage to supply the agreed amount of money to the fund.

The committee that manages the fund is composed of the following representatives: the Mayor of Pimampiro, the municipality's Financial Director, the Director of the UMAT, the President of the municipality's Environmental Commission, and a representative of CEDERENA (Municipalidad de Pimampiro, 2002). Although the rules governing the Committee were are not formally approved at the time of writing, they include the following responsibilities:

- fund management;
- authorisation of quarterly payments based on UMAT's inspections;
- analysis of agreements with landowners and determining sanctions in the case of violations;
- analysis and approval of payment increases;
- approval of the incorporation of new beneficiaries;
- proposing of strategies for fund's sustainability;
- evaluation and control of the fund´s development.

The committee determines the amount to be paid to each family that owns lands in Nueva America, after verifying the property titles, measuring the holdings and inspecting the condition of the land.

Payment categories

CEDERENA classifies the land according to categories and measures each area. Monthly payments are determined based on the available resources, as shown in the table below.

Table 3.1 Payments by category

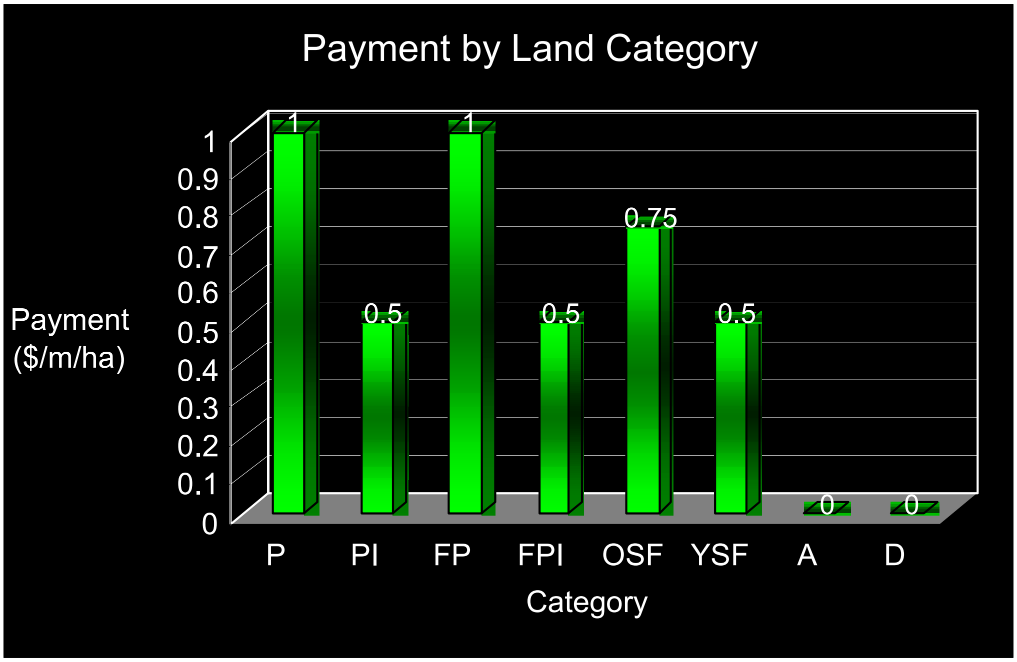
Abbreviation	Payment categories	Payment ($/month/ha)
P	Páramo where no human activity has taken place	1.00
PI	Páramo where human activity has taken place	0.50
FP	Primary forest	1.00
FPI	Primary forest where human activity has taken place	0.50
OSF	Mature secondary forest	0.75
YSF	Young secondary forest	0.50
A	Agriculture and livestock	0
D	Degraded land	0

These payments are a result of political negotiation rather than a technical analysis of the hydrology, water valuation, or the financial planning of the fund. CEDERENA initially proposed an increase in the water tariff of 40 per cent but the city council only approved a 20 per cent increase. However, these figures are considered to be only a start, and the tariffs may increase in the future as the market for watershed services develops and more resources are generated.

To receive payment, each member of the Nueva América Association must sign an agreement with the municipality of Pimampiro (CEDERENA, 2002). The agreement stipulates which areas are covered and determines payments in accordance with current land use, and establishes a land management plan for the property (this requirement has not been fulfilled).

Landowners who violate the forest conservation agreement after signing up to it have their payments suspended for one quarter. If the violation is repeated, the suspension lasts for two quarters, and if one more violation is committed, the participant is excluded from the payment system. UMAT has been reporting violations to the Ministry of Environment so that sanctions are imposed in accordance with the Forest Law. In the case of páramo, the law is more ambiguous (CEDERENA 2002).

Figure 3.8 Payment by land category



Notes: Landowners will be paid according to the vegetal cover of the land. The categories are paramo P, paramo with human activity PI, primary forest FP, primary forest with human activity FPI, old secondary forest OSF, young secondary forest YSF, agriculture A and degraded D. *Source*: CEDERENA 2002.

3.4.2 Drivers

The Pimampiro initiative appears to have been driven by supply and demand considerations. On the one hand, the DFC experience with landowners highlighted the importance of creating incentives to improve natural resource management. On the other hand, the town has been subject to serious water shortages, so decision-makers were concerned about protection of the water sources. In particular, the former mayor appears to have been an important promoter of UMAT and provided the leadership to mobilise the payment concept.

3.4.3 Payments to date

Payments began to be made in January 2001. They are made on a quarterly basis. The committee chooses four families at random and technicians from UMAT, CEDERENA and the municipality evaluate the condition of their land. The technicians write a report which is assessed by the committee before payment is made. The table below shows the payments effected to date.

Table 3.2 Payments made

Quarter	Total paid (US$)	Number of families with agreement	Observations
January – March 2001	1,067.70	27	
April – June 2001	1,100.19	27	3 violations prompted removal from system
July – September 2001	1,099.17	24	4 violations prompted removal from system
October – December 2001	952.02	22	2 families reinstated
TOTAL 2001	4,219.08		
January – March 2002	974.82	16	1 reinstated
April – June 2002	848,46	15	1 violation
July – September 2002	827.78	15	

Source: For 2001, CEDERENA 2002, for 2002, Municipality of Pimampiro.

3.4.4 Penalty system

The municipality of Pimampiro and CEDERENA have yet to develop a structured penalty system but are 'learning by doing'. Penalties have been imposed ranging from the cancellation of payments for one month to a total exclusion from the system. In the two years that the system has been in place, it is evident that sanctions are required. The most common violations are:

- Slash-and-burn practices. This has prompted immediate removal from the list of beneficiaries and action by the Ministry of Environment to impose penalties.
- Unauthorised selective timber extraction.
- Soil and undergrowth extraction.

3.5 Impact assessment

As stated previously, assessing socio-economic impacts is a difficult task. This is particularly so in rural communities, where there are often logistical problems. The task of conducting interviews with the Nueva America landowners in Pimampiro was not easy. After five separate visits by different organisations to Nueva America, 11 landowners were finally consulted, of a total of 24 association members of whom 20 who participate in the payment system. This difficulty may have been due to survey fatigue, since other studies have been carried out there recently, or because of incentives issue, as discussed below.

The small sample size does have the advantage of confidentiality. As not everybody participated, no one can assume what other people said. The sample indicates that there is a particular generational point of view. The average landowner is 51 years old.

The results of the consultation can be seen in Annex 1. The median holding size is 42 hectares. The level of education is low, with the highest grade of education attained being 6^{th} grade, and seven of the 11 respondents reading a newspaper only once a year. All except one of the respondents live in the middle part of the watershed and move to the upper part, where the forest is located, whenever there are difficulties where they live, such as a bad harvest.

3.5.1 Social impacts

In situations where compensation is being discussed, it is difficult to ensure "honest" responses from those consulted. People often answer strategically to maximise their benefits. The average payments received were US$21.1 per month, which is less than half of the family's income. Monthly expenditure on food, medicines and schooling totalled an average of US$60.8. Therefore, the payments do appear to supplement the family income. It is worth highlighting that the legal minimum wage in Ecuador is US$114 per month. However, nine of the 11 consulted were motivated by the payments to conserve, five of them indicating that they were "somewhat" motivated.

Measuring issues of welfare (such as income, consumption, and well-being) effectively is difficult and can become speculative. Respondents indicated that the last payment was used for food and gas, while the next month's payment would be used for education. This response was influenced by the time at which the consultation took place, ie, near the beginning of the school year. Although it is impossible to verify effectively what the resources are used for, it appears that the payments are used to fulfil the families' short-term needs.

An interesting fact to bear in mind is that only one of the 11 respondents indicated that they cooked with gas. This is likely to be the person who lives in town. From discussing the issue with the CEDERENA staff, it appears that there is a cultural preference for cooking with firewood despite having to go out and fetch wood every day, and having to go a little further to fetch it each time. There is still a preference for the flavour that the firewood gives to the food and there is also the social significance of sitting around the stove in the family kitchen. Moreover, gas has to be paid for while firewood is still considered to be free. This is a challenging situation given that the need for firewood may be an added pressure on the forest. However, most families do have stoves and they use gas for heating things.

The average compensation received ranged from US$0.10 to US$1.00 per hectare. These variations are the result of differing information used to calculate payments (GPS measurements differ from those in the land titles) and of the difficulty in understanding the value of money, since the dollarisation of Ecuador's economy.

Meanwhile, the average amount suggested as a fair payment to protect the watershed was US$1-10 per hectare. For the citizens of Pimampiro, the majority (35 out of 36) agreed that it was necessary to protect the forest in order to guarantee water provision, and over half (22 out of 36) were willing to pay more for it. They considered US$3.70 per hectare to be a fair level of compensation to the landowners.

Therefore, the payment does not seem to meet expectations. However, following discussion with representatives of the municipality and CEDERENA, it was suggested that the participants were "never satisfied and always expected more". For example, when the system was being established, the Association wanted to be paid according to land values. The mayor suggested that the situation had become unmanageable as landowners could "extort" payment from the municipality threatening to deforest if they were not paid (Lora 2002).

On the question of whether water is a right or a good, respondents from Nueva America seemed wary in answering – eight of the11 did not respond to the initial question of whether people have a right to water. On further clarification of the concept, the interviewer perceived that the cautious responses were because they thought that their answers might affect their level of compensation.

The payment does seem to improve awareness of environmental regulations. Nueva America respondents were conscious of the legal restrictions on deforestation. On the question regarding the use of the payments, 8 of the 11 responded that they were not able to change the land use. Only two of the 11 considered that the payments did not encourage conservation. This response contrasts to the answer of those consulted in Pimampiro where 18 of the 36 consulted stated that landowners could clear the land if they were not paid.

This awareness was also illustrated by the responses about having interest in alternative activities (seven were interested in medicinal plants, ten in ecotourism, five in sustainable agriculture), though their involvement in CEDERENA activities was not verified. Ecotourism seemed of greatest interest - ten of the 11 expressed interest. Yet, from the answer to the question of whether the payments encouraged participation in more sustainable activities, seven of the 11 claimed it did not. From discussions with CEDERENA, it appears that the move towards a more conservation-minded attitude is slow to take off. People still hope to be able to change their land use in the future.

The payment system does not seem to have strengthened the level of organisation; nine of the 11 respondents indicated that the Association is less organised than before the payment system was established. CEDERENA believes that this is a characteristic of this community in general which was not very well organised to begin with. Moreover, the change from communal ownership of the land to individual titles weakened the role of the Association. Yet, one of the benefits of the payment systems should be the strengthening of social organisation. Formerly, the group united to address land tenure issues, now there is an opportunity to unite to achieve common conservation goals, such as ecotourism.

There does not appear to be resentment or conflict among the Nueva America members, nor with the downstream users in Pimampiro. The consultation demonstrated that the creation of the fund and the increase in the tariff had not been well explained to the community.

3.5.2 Transaction costs

The development of any market or payment systems implies costs, be they for labour, infrastructure, research, etc. Thus, it is important to understand these costs in order to ensure the economic, political and social viability of the mechanism.

It is difficult to assess the transaction costs of the Pimampiro case. In addition to the sensitivity of this information, the fact that it is the first experience of its kind in the country has meant that other programmes or projects have heavily subsidised the process, and there are therefore hidden costs. The creation of the municipality's environmental unit was important for the payment mechanism, but it also provides additional benefits.

For the sake of discussion, we estimate the costs of the main components of the Pimampiro payment system as follows:

Table 3.3 Estimated costs of the Pimampiro payment system

COMPONENT	TIME	COST $	SPONSOR
Forest Management Plan	1996-2000 3 years		DFC, FAO, Cederena
IAF Project with Cederena, including: studies undertaken by Wilson (2001) and Lascano (2002)	3 years	30,000	10% of the project
Development of system: Collect information, Organise actors, Set prices, Negotiation, Organise payments	1 year: 1 month 1 month 1 month 1 month 1 months		Cederena Cederena -UMAT
Development of municipal ordinance	3 months		DFC, FAO, Cederena, UMAT, Tax Office
Seed money for the fund		15,000	IAF, DFC and users
Improvements in water infrastructure			Church, Provincial Council, BEDE loan
Administration of the system			UMAT, Cederena
Administrative costs for payments			Bank and municipality
TOTAL		> 45,000	

UMAT is responsible for monitoring the system, imposing penalties, collecting payments, and negotiating contracts.

It can be assumed that the transaction costs for the development of these mechanisms are high. A conservative estimate would be a cost of three times the amount paid in the first year of the payments, assuming an annual cost of $15,000.

3.5.3 Sustainability of the fund

Pagiola et al. (2002) describe the sustainability of a market mechanism as being dependent on a combination of demand, capacity to supply, and the institutional structure to maintain it. At present CEDERENA is working on a strategy to address supply and demand. The strategy aims to cover the costs of technical assistance and monitoring, activities which are currently subsidised by the CEDERENA project. The idea is to have an institutional arrangement where UMAT can regulate and control the payment system but an independent organisation is in charge of monitoring (Yaguache, 2002).

As part of this strategy, several valuation studies have been undertaken, including one quantifying the opportunity costs of habitat conservation (Wilson, 2001) and one estimating the total value of the water from the Del Pueblo irrigation canal (Lascano, 2002). According to Lascano (2002), the monthly collection of the 20 per cent tax ($US199.64) does not cover the payments, which amount to US$454.72. In order to protect all the water sources, an area of 4,200 hectares, the payments would have to increase to approximately US$4,000 per month. Therefore, the inclusion of the irrigation systems is vital to expand the demand for the service. However, no action has been taken to involve irrigation, and substantial lobbying may be required in order to do so. One of the recommendations arising from this study is the possibility of involving agricultural producers through a property tax, which would also be collected by the municipality. Since the water tariffs are overseen by a different government body, the application of a tax or incentive based on water consumption could be interesting. However, the economic and political viability of this idea still needs to be assessed.

A significant gap that needs to be addressed in this area is the lack of hydrological data to demonstrate the link with the forest cover.

In addition, the institutional viability of the mechanism is not clear. The IAF funding is coming to an end and there seems to be no clear explanation about what will happen with the payment scheme. The municipality is looking for another partner such as Cederena. Cederena would like to develop a project that would create a more participatory institutional structure which would include other actors in addition to the municipality.

3.5.4 Recommendations

The following recommendations came out of Joseph Vogel´s economic analysis:

1. Change the title from "Payment for environmental services" to "Payment for protection of environmental services", and launch an educational campaign.

2. Raise $3,456 by setting progressive water tariffs, exempting the first 0-17 m^3 per month.

3. Raise $60,544 by liaising with the water boards to increase the water rates for irrigation. If the water boards are not agreeable, the municipality could levy an agricultural tax based on the volume of water used.

4. Prioritise areas to be protected according to the level of water produced. A hydrologist with experience in the region should be consulted.

5. Integrate into a Geographical Information System (GIS):
- costs of protection by habitat type and its situation with respect to the "edge effect";
- the hydrological productivity of each type of habitat;
- land titles in the watershed

6. Solicit funds from past international donors to refine the payment mechanism and to and extend the "payments for protection of environmental services" system to other landowners in the watershed.

7. The 27 families in Nueva America currently receiving "payments for environmental services" should continue to receive payments that are at least equivalent to those they received under the pilot scheme.

These recommendations were presented to the city council in November 2002.

4 Integrated water resources management in Cuenca

4.1 Background

Cuenca is located in the southern part of the Ecuadorian Andes. As Ecuador's third most populous city, it has a large industrial sector. Agricultural and livestock activities are important in the both the temperate and subtropical ecological zones surrounding the city (Wunder, 2000).

Cuenca's social and economic indicators are better than the national average. "Cuencanos" are noted for being dynamic and independent. The area has been affected by mass emigration of its inhabitants to the United States and Europe in search of work. Although this provides substantial income from remittances, it also aggravates social problems.

The city's population was reported to be approximately 277,000 in 2001 and the population of the entire municipality was 428,000 (both urban and rural communities) (INEC, 2002). Although 98 per cent of the city's population has access to drinking water, the municipality has become concerned about the future supply of water and the possibility that water quality and quantitiy will deteriorate in the long term. Thus, efforts have been made to prevent this. The local government utility that manages telecommunications, drinking water, sewerage and wastewater treatment (ETAPA) is considered exemplary within the region and the country because of its efforts to manage water resources in an integrated fashion.

4.2 Water supply

The city of Cuenca has four main watersheds: Machángara, Tarqui, Yanuncay and Tomebamba. These four rivers flow into the river Cuenca.

4.2.1 Vegetal cover

The southern Andes are geologically older than the northern Andes and do not have active volcanoes. The mountains tend to be lower than those of the northern Andes, so plant species are different from those in the north. In general, the land cover is categorised as humid montane thicket, dry montane, montane cloud forest, and herbaceous grasslands (Sierra, 1999).

Humid montane thicket covers all of the inter-Andean valleys located at altitudes of between 2,000 and 3,000 metres above sea level. Most of the original vegetation has been destroyed and has been replaced by crops and eucalyptus forest (*Eucalyptus globulus*). The remnants of the original vegetation are located on steep slopes (Sierra, 1999). The original species of thicket nourished the soil and generated humus while the introduced eucalyptus species dries the land and prevents other plants from growing.

The montane cloud forest is located between 1,500 and 2,900 above sea level. Most of the trees in the forest are covered with moss and there is a wide variety of epiphyte plants such as bromeliads, orchids and ferns. This cloud forest is one of the most diverse in terms of vegetation (Sierra, 1999). The plants that grow in this cloud forest are known for their water retention capacity and for their ornamental and medicinal uses.

Herbaceous grasslands begin at altitudes of 2,800 metres above sea level. It is dominated by grasses of the genus *Calamagrostis*, *Festuca* and *Stipa* (Sierra, 1999). These species are found growing among other smaller species that have adapted to the low temperatures the wind. This páramo has leguminous species like *Lupinus spp*, from the Fabaceae family, which add nitrogen to the soil. There are also Gentians, known for their beautiful flowers and their capacity to retain water.

4.2.2 Hydrology

The Macua Project, a river monitoring system, which was established with Inter-American Development Bank funding at the University of Cuenca to prevent floods and landslides, compiled the following hydrological data.

Table 4.1 General hydrologic information for Cuenca

Items	Unit	Tomebamba	Yanuncay	Tarqui	Machangara
Hydro meteorological					
Average rainfall	mm	1097.00	1132.00	840.00	1142.00
Average Flow	m^3/s	7.30	6.34	3.59	6.64
Maximum Flow	m^3/s	124.00	145.00	127.00	150.00
Minimum Flow	m^3/s	0.69	0.81	0.5	0.54
Flow	$l/s/km^2$	24.30	15.91	7.51	20.58
Physical					
Area	km^2	335.50	408.90	478.05	323.40
Perimeter	km	74.71	115.76	103.53	94.24
Length of river	km	23.00	42.50	48.00	40.00

Source: Macua Project. 2002

The four watersheds that supply water to the city form the Cuenca river which drains into the Paute River. This, in turn, drains into the Amazon, whose importance was discussed in Section 1.

A key feature of this area is the soil formed by a delicate layer of volcanic ash on top of old lava. This contrasts with the soil in the north of Ecuador, which is young and rich in volcanic matter, and has the ability to retain water (Medina y Mena, 2001). A large proportion of the soils in these watersheds have a high water retention capacity (Macua, 2002). The páramo is located on andosols, which are light very porous volcanic soils capable of storing large quantities of water (Buytaert et al., 2000).

The rainy season is from January to May. The most humid watershed is the Tomebamba watershed, due to rainfall and the presence of black soils in 65 per cent of the watershed (Macua Project, 2002).

The source of the above named rivers that flow into the Paute is the Cajas National Park. The park gets its name from the 230 lakes which are scattered throughout the park and look like *cajas* or boxes. The park is located at an altitude of between 3,150 and 4,300 metres above sea level. It has an area of 28,800 hectares and is mainly formed of páramo.

Of the area under production, the 70 per cent of the land in these watersheds is used for grazing and 30 per cent is used for agriculture (Dominguez, 2002b). Land tenure is divided as follows:

- Private individual land holdings:
  - large and small cattle ranches in the upper Yanuncay and Tomebamba watersheds;
  - small land holdings for potato and grain cultivation.

- Community land holdings for agricultural production, particularly corn and bean production in the lower Machángara watershed.

As areas are becoming deforested for cattle raising, the soils are rapidly deteriorating. There is growing concern about the impact on water flows, particularly in the dry season, and about soil erosion which produces sediment in the drinking water.

ETAPA has two water treatment plants: Tixán and El Cebollar, treating a water flow of 1,800 litres per second (Dominguez, 2001). At present, the two main watersheds, Machángara and Tomebamba provide 17.5 m^3/s to meet the city's demand (Tomebamba provides 40 per cent and Machángara 60 per cent) (Dominguez, 2002c). The city's treatment plants process 4 million cubic metres of water per day. Losses are estimated to be around 45 per cent. Payment collection has an 82 per cent efficiency rate (Dominguez, 2002b).

Despite the abundance of water, Lloret (2001) highlights a series of problems that have caused concern to ETAPA, including:

- *Water use*: more water has been assigned than is available, as shown in a study of the Machángara watershed carried out by the National Council for Water Resources.
- *Erosion:* sedimentation in the reservoirs creates problems for hydroelectricity generation, water treatment and irrigation.
- *Wastewater pollution*: contamination from abattoirs, plantations, and wastewater from rural communities seriously affects water quality.

4.3 Water demand

The four watersheds supply water for the following uses:

- drinking water for the municipality;

- irrigation for potato, grain and other cultivation;

- cattle raising for dairy production;

- recreational activities and local, national and international tourism such as fishing and thermal springs;

- Elecaustro, the electricity utility, which generates 50 per cent of the electricity for Cuenca city and the provinces of Cañar, and Morona Santiago from its Machángara plant;

- Cuenca’s industrial park, which takes water directly from the river Machángara;
- trout farms.

The study does not quantify the different water uses, but focuses on the principal user, ETAPA.

ETAPA estimates that the drinking water system covers 99.1 per cent of the families in the urban area of Cuenca. Of the 59,712 homes in the payment system, 95 per cent have meters. The rural area has 139,064 users and the system covers only 61.8 per cent of the population (ETAPA, 2002b).

Table 4.2 Water consumption in Cuenca

	Consumption m^3	**% Users**	**Payment US$ /m^3**	**Observation**
RESIDENCIAL	0 – 20	45 %	0,20	All the users have to pay US$2 per month for the access to the service.
	21 - 40	35%	0,30	
	+ 40	20%	0,65	
COMMERCIAL/ INDUSTRIAL	0-50		0,70	The tariff for the access to the service is 4 US$ per month.
	+ 50		1,05	

Source: ETAPA, 2002b

4.4 Linking supply and demand

Urban drinking water users, who are usually located downstream, have an interest in receiving a stable and good quality service. This service can be affected by upstream landowners and water users so the latter should therefore be involved in the protection of water resources. ETAPA is a pioneer in Ecuador in linking upstream and downstream water uses and develops activities to ensure the long-term provision and protection of water resources. The following section will describe ETAPA´s initiatives, which have evolved over time. What began as a land acquisition programme developed into a programme of integrated management of water resources, which includes protection of watersheds, rational use of water and treatment of wastewater. The company hopes to apply payments for environmental services in the future.

This is an interesting contrast to the Pimampiro experience, and this study hopes to enable the two projects to learn from one another. The link between downstream water users and upstream landowners is being made in Pimampiro by the application of a payment system for protecting the forest. In the case of ETAPA in Cuenca, the link is being made through the Environmental Management Unit, which has a securely-funded consolidated watershed protection programme.

In the early 1980s, ETAPA developed a municipal master plan for water, which included three main strategies: water supply, rational water use and wastewater treatment. As the local water utility, ETAPA assumed responsibility for carrying out these strategies in accordance with environmental regulations that were directed towards reducing water pollution and decentralising environmental control responsibilities. ETAPA was charged by the Environment Ministry with enforcing pollution controls in the city. ETAPA’s Environmental

Management Unit designed programmes which included control of industrial wastes and waste oils, limnology studies, environmental education, wastewater treatment, hydro meteorological networks, environmental laboratories, geographic information systems, air quality monitoring, and management of protected areas (ETAPA, 2002).

The growing awareness of the threats to water quality and quantity was a significant factor in the development of ETAPA's water enterprise. The main drivers of this project were Agustín Rengel, who provided leadership as ETAPA´s general manager in the 1980s, and the city's cultural heritage. In addition, ETAPA has historically been a very well run technical institution, whose technicians take a long-term view. Thus, their commitment to protecting the watersheds was taken seriously (Dominguez, 2002b).

To guarantee the conservation of key areas and reduce the pressure of local communities, ETAPA has implemented the following activities since the 1980s.

4.4.1 Acquisition and protection of land

Over the last two decades, the utility has bought land in critical areas around the Tomebamba watershed, as shown in the table below.

Table 4.3 Land bought by ETAPA in Tomebamba

YEAR	CUMULATIVE AREA (Hectares)	CONSERVATION AREA
1984	3,623	Mazán
1996	5,251	Llaviuco
1998	8,382	Hato Chocar
1999	8,759	Llulluchas

Source: Lloret, 2000.

In 1984, the company bought the Mazán forest. By the year 2002, 21 per cent of the Tomebamba watershed, which generates 30 per cent of the water for Cuenca was under ETAPA's protection. The company continued to buy land until 1999, by which time it owned a total of 8,759 hectares, composed of 7,253 hectares of páramo, 1,410 hectares of regenerated land, and 96 hectares of pasture (Lloret, 2000).

In 2000, as part of the Environment Ministry's effort to decentralise, ETAPA was granted a concession to manage Cajas National Park, which was the first concession granted of an area within the protected areas system. ETAPA will manage and protect the park with the oversight of the Ministry of Environment. The entrance fees will be managed by ETAPA with a percentage given to the Ministry of Environment to subsidise other areas of the park system. ETAPA is currently promoting Cajas National Park's status as a Ramsar Site and a UNESCO World Heritage Site (ETAPA, 2002b). ETAPA has also developed specific agreements with Cuenca University in relation to biological research in Cajas National Park.

Owing to these efforts, 11 per cent of the area of the municipality of Cuenca is now under protection (Dominguez, 2002b).

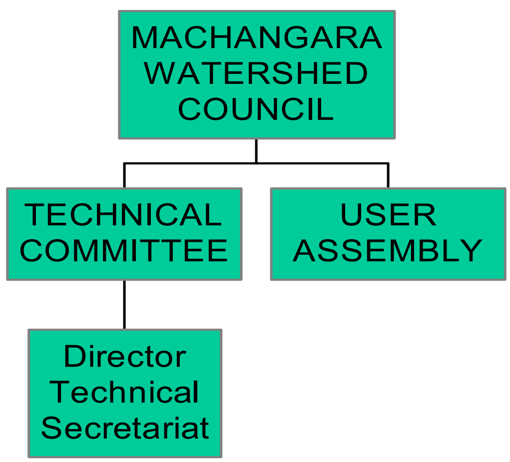
4.4.2 Machangara Watershed Council

Besides providing 50 per cent of the water for Cuenca, the Machángara watershed also serves 120 industries (50 per cent of city's industrial park), generates the region's electricity and provides water for cattle ranching and fish production activities.

In July 1998, led by ETAPA, the Watershed Council was created order to provide an adequate legal framework to guarantee the conservation of the resource with the participation of the water users (Lloret, 2000). This Council has nine member institutions: the electricity utility (Elecaustro), the Centre for the Economic Development of Azuay, Cañar and Morona Santiago (CREA), the National Water Council (CNRH), Cuenca University, the Azuay provincial government, the Environment Ministry, the water irrigation board of the Machángara river (which includes 4,500 families that use a major irrigation canal in the lower part of the watershed), the municipality's environmental council, and ETAPA.

The Council was formed with the objective of coordinating among the participating institutions and users the sustainable development of the watershed.

Figure 4.1 Council structure



The Council is the principal decision-making body and is composed of the most senior representative of each member institution and a representative of the User Assembly. Each of the council members nominates a technical representative to the Technical Committee. The Technical Committee has a permanent secretary who is the Technical Director of the Council and is responsible for preparing the plan of activities. The Technical Committee meets monthly and presents the plan of action for approval by the Council. The funding for all the activities is provided by the member institutions.

The following activities have taken place:

- studies to analyse and control the damage caused by landslides from the Soroche stream;
- water quality and soil studies in the watershed;
- installation of four meteorological stations, connected to the network in the Paute watershed;
- in conjunction with the National Water Resources Council, a comparative study of the available water versus the water designated for all users in the watershed;

- through a participatory process, the design of a Development Plan for the 110-member Board of Machangara Irrigators, which then evolved into the preparation of a Development Plan for Chiquintad, a small town of 3,000 people.
- technical assistance to a 55-member savings cooperative in Chiquintad for the development of an ecotourism operation in a native forest;
- development of a reforestation plan in three villages of the middle and upper part of the watershed with a total population of 6,00 people. One hundred and forty-four hectares were planted with 86,400 trees, which has greatly improved the relationship between the electricity utility and the community;
- creation of community nurseries with over 50,000 trees;
- training in the growing of native tree species;
- creation of 60 family gardens which, besides providing food for the household, enables some surplus to be sold locally;
- improvement of pastureland;
- establishment of a soil conservation programme;
- community training for pastures, family gardens, rational use of water, and beekeeping for adults and children;
- bee production with 18 women from the town of Sidcay;
- use of non-forest products.

All these activities have been designed and included within the yearly operational plan prepared with the participation of all the members.

4.4.3 Wastewater treatment

As mentioned previously, Cuenca was the first city in Ecuador to treat its wastewater. Initially wastewater collectors were built with a loan from the Interamerican Development Bank and as part of the city's water management plan. Then, as part of a second phase, the treatment plant was established. Currently, the city treats 95 per cent of its wastewater. ETAPA has also enforced industrial pollution control regulations.

4.4.4 Funding

ETAPA has developed an accounting system that incorporates the costs of watershed management. The company considers that its break-even point is 45 cents per cubic metre, which is composed of the costs outlined in Table 4.4.

Table 4.4 Costs per cubic metre of water

Activities	**Investment (US$/m^3)**	**Operation and Maintenance (US$/m^3)**	**Total (US$/m^3)**
Watershed management	0.01	0.04	0.05
Raw water uptake and transportation	0.04	0.00	0.04
Treatment and distribution	0.23	0.13	0.36
TOTAL	0.28	0.17	0.45

Source: ETAPA, 2002b

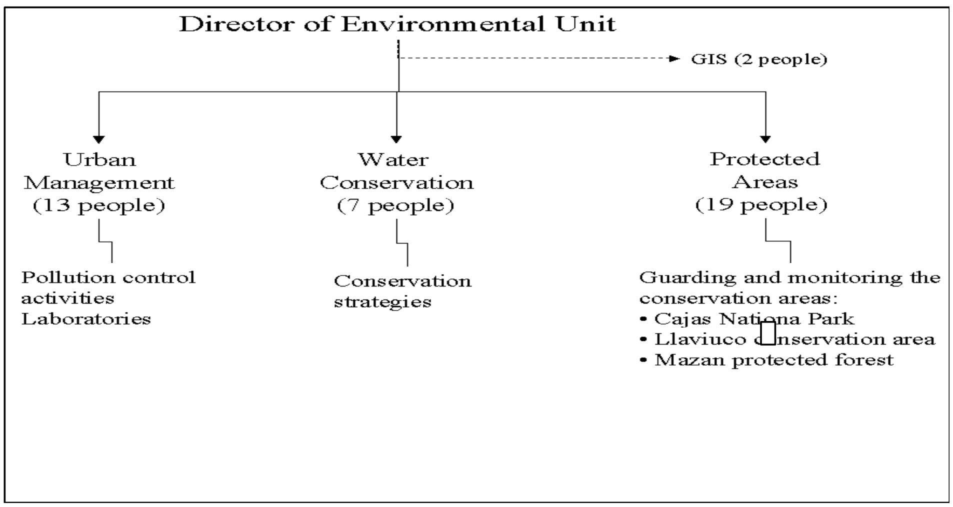
Water use is metered. At least 80 per cent of city's domestic water users receive a subsidy; users are not paying the real cost of the water service, which is still subsidised by the

ETAPA's communications business. Water users are unaware that they are paying for the protection of the watershed. Furthermore, wastewater treatment is currently not charged to the users, but is also subsidised by ETAPA's communications service. It is very interesting to see how ETAPA incorporates water treatment and the conservation of the water source into the structure of their business, which is unique in Ecuador, and indeed the region.

The Environmental Management Unit receives $0.05 for every cubic metre of water sold. Payments are directed to a specific account in the Unit's budget. The institutionalisation of this figure has been gradual but the figure has now been accepted by the company's board. For 2002, this meant a budget of US$1,089,000 (Dominguez, 2002b).

The Environmental Management Unit has a team of 42 people working in four different areas as shown in Figure 4.2.

Figure 4.2 Cuenca's Environmental Manage Unit



Source: Jaime Domínguez

ETAPA´s board is composed of the mayor, who presides over it, three members of the city council, a citizens' representative, a municipal government official, a representative from the professional colleges and a representative from producers' associations. Any decision regarding the tariff structure has to be ratified by the 14 member-city council. One would expect from this board composition that the decisions are very political. On the contrary, decisions are taken on a technical basis. In respect of the Environmental Management Unit, the board always considers the advice of the technicians and ensures that resources are allocated for environmental activities. The company is expecting to make a decision regarding a tariff to cover the costs of wastewater treatment, which is currently subsidised by ETAPA's communications business as mentioned above.

4.4.5 Payments for watershed services

ETAPA is planning to expand the drinking water system by taking water from the upper part of the Yanuncay river, near the settlement of Soldados, which is 27 kilometres from the city. This project is expected to begin operation in the year 2005 and add 31 per cent more water to the system. Given the fragile conditions of the basin and the fact that there are many private landholdings, ETAPA wants to develop a system that encourages the conservation of the forest cover by establishing a direct payment system (Dominguez, 2002a). See Box 4.1 for a further description of the site.

Box 4.1 Potential sellers in the Yanuncay Watershed

The main economic activity of the families in the Yanuncay watershed is livestock production. A significant area of the watershed is under pasture, an economic activity that appears to be expanding. Even though the forestry law prohibits land use change, slash-and-burn practices are commonplace among local families. Some families are also involved in other economic activities such as commerce, or they work in other cities near Cuenca.

One of the main problems of the Yanuncay watershed is the threat of flooding at certain times of the year. The Inter-American Development (IDB)-funded Macua Project found that the population density, the very narrow river canyon, and the impact of local construction methods were some of the factors that make this watershed a priority area for conservation activities (Macua Project, 2002). This watershed is highly susceptible to floods and landslides. If the cattle ranching and agricultural activities persist, ETAPA fears there will be problems with water supply, erosion, and increased sedimentation in the Yanuncay river, which will affect the city's supply.

Besides cattle and agricultural activities, the watershed offers tourism opportunities as another source of income. Since part of the watershed is in the Cajas National Park and there is a road from Cuenca to the Park along the river, the communities have an interest in ecotourism. Thus, they have promoted reforestation in order to "green" some areas and also to reduce the pressure on the forest from charcoal extraction. Although most of the reforestation has taken place with exotic species, eucalyptus and pine, there are now nurseries of native species. A priest from one of the settlements and some landowners are developing a plan for a tourist corridor along the river and have received resources from a European Union programme to develop the idea. Tourism could involve 30 per cent of the population of the watershed (Durán, 2002).

It is difficult to compete with the economic benefits of cattle ranching activities in existing areas. Therefore, ETAPA is interested in developing a payment system, which would provide an incentive to the families who hold title to the land to conserve the forest.

Consultations took place in the Cuenca and Yanuncay watersheds in order to compare the situation with that of Pimampiro, where a payment system exists.

4.5 Impact assessment

The consultation results can be seen in Annex 2. Of the Yanuncay respondents, the property owned ranges in size from 2 to 300 hectares, with an average of 64 hectares. The highest level of education attained in the group is 6th grade, and the majority (20) read a newspaper once a year.

Monthly expenditure on food, medicines and schooling averaged US$108. Therefore, the payments would constitute less than half of total income. Meanwhile, the average amount considered to be a fair payment to protect the watershed was suggested as US$9 per hectare.

The main uses of the payments would be to buy food (6), to buy small animals (5) and improve irrigation (4).

The respondents from Yanuncay appeared to be unaware of the legal restrictions on deforestation. Twelve of 24 interviewed were aware that they could not clear the land. However, nine thought they *could* clear the land. In Cuenca, 19 of 49 interviewed were aware that they could not clear the land. This illustrates the level of public confusion on this matter.

In terms of the cultural preference regarding water as a right or a good, the Yanuncay respondents were clearer than those of Pimampiro in their responses: 24 of 24 said that provision of sufficient water to cover basic needs was a right. Twenty-three of the Cuenca respondents did not answer this question.

The responses from the Cuenca interviewees show their environmental awareness. Of the 49 consulted, 47 supported the conservation of the Yanuncay forests. Half (25 of 49) were willing to pay for it. It is important to highlight that the responses may be affected by the recent tariff increase, which was mentioned frequently during the consultations. The mean amount considered to be a fair payment for protecting the watershed was suggested as US$3.37 per hectare.

The demand side drivers such as a willingness to pay appear to be strong in Cuenca. There is a very solid and well developed institutional infrastructure within which to establish a payment system. In addition, the institutional capacity, the resources available and the interest in market mechanisms provide potential for applying a payment system. However, the success of a model depends on the socioeconomic context. For example, the opportunity costs of land and labour in and around Cuenca are different to those of Pimampiro. There is also a difference in the level of consumer surplus for the value of water for commercial and residential use. In addition, Cuenca and its surrounding areas might be subject to higher costs and values because of the boom in the remittances sent by emigrants. Paying landowners to protect the forest could have detrimental effects in that improved socioeconomic conditions could lead to conspicuous consumption, which could in turn aggravate deforestation pressures. A recent economic study (Wunder 2002) demonstrates that this is the case in Cuenca particularly because the deforestation cycle includes a cattle raising phase, an activity that owing to the high level of male migration in Azuay (the province where Cuenca is located) has become more attractive for the female population left behind.

4.5.1 Recommendations

Vogel (2002) provides some interesting recommendations for ETAPA should it apply a payment system:

1. Identify the areas that are most susceptible to urbanisation in the lower river basin (Sustag and San Joaquin) and inform landowners about the relevant laws. Monitor land use and impose sanctions when necessary.

2. Hire local people involved in the ecotourism corridor for infrastructure and public education activities.

3. Identify ownership of lands already forested in the upper river basin (Soldados) and inform landowners about relevant laws. Monitor land use and impose sanctions when necessary.

4. Offer to pay the opportunity costs of cattle in the areas adjacent to the forested or riparian lands or buy the title outright, whichever is most cost-effective.

5. Hire local people from the upper river basin to carry out reforestation and involve them in extractivist and agroforestry activities.

6. Revisit the water pricing policy, dispensing with the system of discounts for public institutions, but exempting charges for the minimum level of consumption ($<20m^3$), and establishing a progressive tariff system in order to finance the costs of Recommendations 1-5.

5. Project results

5.1 Major findings

The key findings of the research can be summarised as follows:

- When discussing markets, it is important to clarify the term "market" and the legal context in which it is operating. There is no market for watershed services in Ecuador at present. However, since monetary compensation is being paid, as in the case of Pimampiro, the term "market" should be thought of as a metaphor, and it might be more correct to say we are analysing a "mixed market". This is also true because there is imperfect information among the market participants regarding the service that is bought and sold (hydrological function – quality or quantity), the value of the service to the downstream buyers (consumer surplus), and the value to the upstream sellers (producer surplus).

- A key element to consider, which is often ignored by economists, is the legal context in which a market can operate. In Ecuador, as in most Latin American countries, land use change is regulated, and water is a public good. Therefore, payments for watershed services have to be consistent with the forest and water regimes in order not to subvert the authority of the state, and to prevent the mechanism from being misused (e.g., "rewards" for good behaviour or extortion by landowners). The research concludes that in Ecuador landowners should be paid for the costs they incur from protecting forests from incursions by third parties. They are paid for *protecting* the environmental services, rather than providing the services themselves.

- Misunderstanding the socioeconomic context in which a market operates can have contradictory effects. Land, labour and opportunity costs vary and can alter the conditions in which a particular environmental service has to operate, as is the case of Cuenca with the link between deforestation and the increase in remittances from abroad. There is also a cultural and political dimension to water, which is too important to be ignored when discussing the marketing of watershed services. Water should be viewed as both a right and a commodity. Sufficient water for human beings to satisfy their basic needs (e.g., approximately 10 litres per person per day in the developing world, according to the United Nations), should be considered a basic human right and should be available free of charge or at very low prices to everyone, especially the poor.

- Consumption in excess of the above level should be paid for progressively, such that as consumption increases, so does price. The price should reflect the natural limits required to maintain and regenerate water quality and volume, including the cost of watershed protection. Although the change must be gradual in order to improve social impacts, the price of drinking water should reflect environmental impacts.

- A payment system or market mechanism as seen in Pimampiro, can change cultural norms, creating a more "neoliberal" mentality, or reinforcing choices based on self-interest, as illustrated by the contrast in the Nueva America and Yanuncay responses (eight out of 11 interviewees did not respond in Nueva America, 24 out of 24 in Yanuncay stated that sufficient water to satisfy basic needs was a right). This could be a double-edged sword because:

- As markets for environmental services are promoted, there is a risk of commodifying water to a point where private rights are established, to the detriment of the basic right discussed above, which could have devastating effects on the rural poor. One extreme scenario could be the penetration of venture capital for the sale of environmental services, prompting the sale of lands. According to the economics of deforestation as discussed by Wunder (2002), the payments themselves or proceeds from land sales could end up being used for conspicuous consumption, which could lead to displacement of people from their homes and lifestyles.

- The pro-market view could argue that payments for environmental services could be a source of income or transfer of resources for the poor rural communities poor that are ignored or abandoned by the State. Paying for their labour to protect the forest or shifting their land use away from pasture could fulfil the environmental objectives of improved water quality and quantity, and at the same time improve their livelihoods. Yet for this scenario to occur, it is important to ensure that environmental services and in particular watershed services, are coherent with the existing forest, environment and water regulations, as well as, the cultural and socio-economic conditions.

- The case of Nueva America indicates that there is increased awareness of watershed services. It is not clear how far this awareness goes beyond the individual land holding or affects other aspects of people's behaviour. For example, all families in Nueva America still cook with firewood and if this is not done in a sustainable way it could put additional pressure on the forest.

- Although it may sound obvious, a clear understanding of what is being bought and sold is essential. If the payment mechanism is not based on technical information, people are paying for something they cannot see or measure. Therefore, the service must be explained in material terms to buyers and sellers.

- When there is a lack of hydrological information, payments for watershed services could actually be a form of insurance against land use change, and this could threaten water services. In this case people are buying an insurance policy, rather than improved water quality or quantity.

- Society should support public authorities in protecting the public's interests by establishing limits for the "market" for environmental services. This has been referred to as governance in the literature and is a major challenge in developing societies, where local authorities tend to be weak and under funded. Given the weak and confusing institutional structure of the water sector in many countries, public scrutiny is essential.

5.2 Setting up the payment system

Based on Pimampiro's experience, the development process can be described in the following ten steps, which may not be sequential:

1. *Identify a situation where there is a "seller" and "buyer" of a watershed service.* Whether it is water quality or flow regulation, it is important to understand the physical function in order to clearly define the "service" to be marketed.

2. *Create the institutional capacity to implement a market mec*hanism. This refers to the environmental unit or department in a municipality or a water company, which need to be established, and strengthened over time to be able to adapt and fine-tune the mechanism.

3. *Develop inter-institutional links.* Whether it is overseen by an international or local NGO, or a national or local government institution, a payment mechanism is complex and requires technical, legal, social, economic and political expertise. Different institutions can provide the different capacities required.

4. *Know what is going to be sold*. In the preliminary studies to design the mechanism, different types of information have to interact. The legal basis for the mechanism has to be clearly defined, and the hydrological benefits of the ecosystem to be protected must be quantified. These may be measured directly or based on secondary information. As discussed by Johnson et al. (2002), even though there is a limited amount of information, there are certain rules of thumb that could be used, for example, beginning with wetland and riparian protection, and protecting existing forest before undertaking reforestation. It is necessary to carry out economic and financial studies to validate the payment scheme. Valuation studies have become fashionable but they should not necessarily be the decision-making tool. As discussed in detail by Nazi et al., they are "an important tool for revealing the relevant incentive structures… rather than a tool for optimal land use." Payments should be realistic to ensure the financial sustainability of the mechanism and should be competitive in comparison with alternative non-conservationist land uses.

5. *Develop and implement a negotiation strategy with the political decision-makers*. Whether it is a city council or a regional board, the legal mandate for a payment scheme needs to be ensured.

6. *Develop environmental education projects for the communities upstream and downstream*. This could include creating awareness about the hydrological importance of the forest and natural habitats and/or rational use of water and the conservation of natural resources.

7. *Develop a formal and transparent organisational structure for decision-making and implementation.* The scheme should have a governing body including several stakeholder representative members (3-5) as a safeguard against arbitrary decisions. A clear and well-structured payment system should include a payment structure and schedule, payment agreements or contracts, sanctions, an appeal process, financial and environmental monitoring systems and an information system. Access to information for the public, especially participants, is vital for market development.

8. *Establish an appropriate payment system*. Ensure that payments are correct and made on time. Otherwise the system loses credibility and participants will be justified in not complying. Payments should be realistic, based both on ability to pay to ensure financial sustainability, and willingness to pay to ensure competitiveness with alternative land uses in the long term.

9. *Monitor and evaluate the process.* It is important to have an independent body to monitor progress and manage conflicts.

10. *Make corrections and reinforce successful measures*. Strengthening institutional capacity over time is fundamental. Payment systems are long-term mechanisms that have to deliver the benefits they were created for. Failure to so lead to buyers' unwillingness to pay for the service.

5.3 Project conclusions

- Hydrological benefits are assumed, not measured or monitored. There is a *de facto* belief that forests mean more and better water. Very limited local data is available to support this claim. Considering the global importance of water and the challenges facing the water sector in the coming years, it is very surprising how little information is available regarding the hydrological functions provided by particular ecosystems. There is a need for further understanding of this relationship and investment in research.

- Besides the need for further research on the hydrological impacts of land use change in general, this information is vital for setting a market clearing price. Buyers and sellers have little information and thus cannot make rational decisions as to what the watershed service is worth. Due to limited resources and high transaction costs, it is important to disseminate the available information regarding national and international experiences. The compilations prepared by Landell Mills and Porras (2002), and Pagiola et al. (2002), and the results from this project could be useful sources of information.

- The focus of most payment mechanisms has been on drinking water and hydropower generation because their economic value is clearly recognised and there is greater willingness to pay for these uses. In addition, the legal and institutional framework clearly identifies the municipal water authorities and hydroelectric plants as key actors in the development of these payment systems. The contrary is found with water for agricultural use. Yet, it is the main and most inefficient use of the resource. Irrigation should be included in the payment schemes, at least in the case of Ecuador. A possible way to do is through a property tax managed by the municipalities, which would be applied according to the volume of water consumed.

- Household surveys may not be the most effective way to gather information to evaluate the social impacts of a compensation mechanism, because people answer strategically. If surveys are used, questions must be cross-referenced in order to validate results.

- The implementation of payment systems can help create institutional capacity to further environmental management. The process in Pimampiro prompted the municipality to enforce environmental regulations (regarding deforestation), which in turn prompted the national authority to act. With the existence of an environmental unit, the municipality begins to address other environmental issues. This process takes time and the sustainability of the process is fundamental for effectively creating environmental management capacity.

- Payment mechanisms are limited for addressing issues of equity. Payments should improve people´s livelihoods, but how far can this be directed? People have to be given the freedom to decide how to spend the compensation received. All of the respondents answered that they would use the next month's compensation payment for basic expenses, such as food, agricultural production, education and health.

- Market mechanisms are not the solution to everything, and they cannot work in a vacuum. Markets for environmental services create incentives for particular stakeholders, but in order to solve environmental problems, they have to be complemented by other environmental policies. For example, there is a need for education on how to improve agricultural production, which would thus reduce pressure on the forest.

- ETAPA provides a useful example of municipal management of water resources that merits further study in order to document the results.

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- Luis Paspuel, Pimampiro´s Water Treatment Plant. September, 2002.
- Robert Yaguache, Cederena, 29 Agosto 2002

ANNEX 1 Consultation Results in Pimampiro

Nueva America Consultation Results

1) *Number of Respondents:* 11

2) *Number of hectares owned:*
   min (11.7) max (119) mean (42.8) sd (31)

3) *Amount received under the Payments for Environmental Services (PES):* min (5.33) max (68.5) mean (21.1) sd (18.2)

4) *The Payments constitute (less than half/half/more than half) of total income*:
   Less than half (11)

5) *Expenditure on food per month*:
   min (20) max (80) mean (41) st (19.5)

6) *Expenditure on medicine per month*:
   min (0) max (33.3) mean (13.7) st (10.7)

7) *Expenditure on fuel per month:*
   min (0) max (1.6) mean (0.2) st (0.6)

8) *School expenditure per month:*
   min (0) max (25) mean (5.9) st (7.6) no response (1)

9) *Do you cook with firewood? Y/N Coal? Y/N Gas? Y/N*:
   firewood (10) gas (1)

10) *The last payment was used for:*
    food (4) gas tank(2) buy seed(1) save(1) tools (1) uniforms (1) no response (1)

11) *The next payment will be used for:*
    school expenditure(3) clothes (1) food (3) savings(1) medicine (1) no response (2)

12) *Have you accessed credit since the Payments for Environmental Services (PES) began? Y/N:*
    no (8) yes (2) no response (1)

13) *Did you report the PES in the credit application?*
    no (1) yes (1) no response (9)

14) *The credit was for:*
    buy cows (2) no response (9)

15) *Are you interested in the collection of medicinal plants? Y/N:*
    no (3) yes (7) no response (1)

16) *Are you interested in ecotourism? Y/N:*
no (1) yes (10)

17) *Are you interested in sustainable agriculture? Y/N:*
no(4) yes(5) no response (2)

18) *Highest level of education attained*:
0 (1) 2nd (2) 3rd (3) 4th (2) 6th (3)

19) *Do you help your children with homework? Y/N:*
no(4) yes(2) no response (5)

20) *I read the newspaper Daily/Weekly/Monthly/Yearly:*
monthly (2) 6-monthly (1) yearly (7) no response (1)

21) *I listen to the radio Daily/Weekly/Monthly/Yearly:*
daily (4) monthly (2) 6-monthly (2) yearly (3)

22) *Do you believe families have a right to water? Y/N:*
Enough to cover basic needs (1) unlimited (2) no response (8)

23) *If it is a right, do you believe families have a right to water YES/NO:*
Yes (4) no response (7)

24) *If water is both a right and a good, at what point does it change from being a right to becoming a good (at a sufficient level for survival/twice sufficiency/thrice sufficiency/unlimited access):*
sufficient for survival (1) no response (10)

25) *In Nueva America, landowners of the watershed are receiving ($0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha/other):*
$0.1(1) $0.2(4) $0.25(2) $0.4(1) $1(3)

26) *The fair compensation for protecting the watershed is ($0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha.):*
$1(2) $2(2) $3(3) $4(1) $5(2) $10(1)

27) *This is because without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.*
Clear the land (8) cannot clear (3)

28) *Does PSE motivate conservation: not at all/somewhat/definitely.*
Not at all(2) somewhat(5) definitely(4)

29) *The association organises (more/the same as always/less) than before the PES.*
More(1) the same as always (1) less(9)

30) *The PES motivates/does not motivate the participation in more sustainable activities.*
Motivates(4) no motivates(7)

31) *The increase in the cost of water for Pimampiro (has/has not) resulted in ill feelings*.
No(8) yes(3)

32) *Pimampiro is being taken advantage by Nueva America (yes/no).*
no(5) yes(1) no response(5)

33) *It is/is not possible to resuscitate a communal system without payments*.
No(4) yes(2) no response(5)

34) *I am/am not worried that outsiders will buy the land of the watershed*.
No (4) yes (5) no response (2)

35) *Age:*
min (38) max (72) mean (50.9) st (9.8)

36) *Sex:*
male (8) female (3)

37) *Number of people in the family*:
min (2) max (12) mean (6.6) st (2.8)

38) *Place of Residence:*
Alisal (2) Mariano Acosta (1) Mirador (1) Nueva America (1) Peñaherrera (1) Pimampiro (1) Rumipamba (4)

Pimampiro Consultation Results

1) *Number of people interviewed*
(36)

2) *Do you have problems with water supply?*
no(30) yes(6)

3) *Willingness to pay: Do you think that conservation of forest is needed to guarantee water supply?*
no (1) yes(35)

4) *Are you willing to pay more in your water bill for forest conservation?*
no(14) yes(22)

5) *A fair level of compensation to the landowners for protecting the watershed is a)$0.0 month/ha b) $0.1 month/ha c) $1.0 month/ha d) $10 month/ha e)other*
min(0) max(10) mean(2.8) sd (3.7) no response (19)

6) *Without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions*.
Clear(18) cannot clear(9) protect (9)

7) *Do you believe families have a right to water? (sufficien for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   Sufficiency for survival (5) unlimited(4) no response (27)

8) *If it is a right, do you believe families have a right to water?*
   No(6) yes(5) no response (25)

9) *If water is both a right and a good, at what point does it change from being a right to being a good (a level of sufficiency for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficiency (16) unlimited (2) no response (18)

10) *Age:*
   min(17) max(82) mean (42) sd(17)

11) *Sex:*
   male (6) female (30)

12) *Number of family members*:
   min(1) max(10) mean(4.3) sd(2.1)

ANNEX 2 Consultation Results in Cuenca

Yanuncay Consultation Results

1) *Number of Respondents:* 24

2) *Number of hectares owned:*
   min(2) max(300) mean(41.2) sd(63.6)

3) *If you were to receive $ 1/ha-mo. for conservation of the forest on your property, this would constitute (less than half/half/more than half) of your total income:*
   Less than half(24)

4) *Expenditure in food per month*:
   min(45) max(400) mean(92.2) sd(69)

5) *Expenditure on medicine per month:*
   min(0) max(50) mean(8.6) sd(13.4)

6) *School expenditure per month:*
   min(0) max(25) mean(7.2) sd(6.7)

7) *You would use the payments for:*
   buy small animals (5) change paramo into pasture (2) improve irrigation canal(4) improve house (2) improve business (2) save (2) food (6) school expenses (1)

8) *And for :*
   buy small animals (2) food (3) improve irrigation (1) improve house (1) save (3) school expenses (1) no response (13)

9) *Highest level of education attained*:
   min(4) max(6) mean(5.5) sd(0.6)

10) *Do you assist your children in their homework*?
    No(18) yes(6)

11) *Do you read the newspaper Daily/Weekly/Monthly/Yearly*:
    yearly (20) twice yearly(4)

12) *Do you listen to the radio Daily/Weekly/Monthly/Yearly*:
    daily(24)

13) *Do you believe families have a right to water? (a level sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
    Sufficient(24)

14) *If it is a right, do you believe families have a right to water?*

Yes(24) no(0)

15) *If water is both a right and a good, at what point does it change from being a right to becoming a good (at a level sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
sufficient for survival(12) twice sufficiency (3) no response(9)

16) *A fair level of compensation for protecting the watershed is a)$0.0 month/ ha b)$0.1 month/ ha c) $1.0 month/ ha d)$10 month/ ha:* e) other? – how do you explain a max of $20?
min($0) max($20) mean($9) sd($4.46)

17) *This is because without payments, landowners: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.* Clear the land (9) cannot clear the land(12) protecting from outside incursions(3)

18) *Age:*
min(24) max(65) mean(37) sd (12.15)

19) *Sex:*
male(9) female(15)

20) *Number of family members:*
min(19) max(65) mean(37 sd(12.15)

21) *Place of residence*:
Capuli(8) Soldados(8) Sustag(8)

Cuenca Consultation Results

1) *Number of respondant*s
(49)

2) *Do you have problems with your water service?*
No(36) yes(13)

3) *Besides the conservation activities of ETAPA in the Cajas National Park, do you think that the forests in the Yanuncay watershed should also be conserved in order to safeguard the water supply for the future?*
No(1) yes(47) no response (1)

4) *Willingness to pay: Are you willing to pay more in your water bill to conserve the Yanuncay Watershed?*
No(24) yes(25)

5) *A fair level of compensation to the landowners in the upper Yanuncay watershed for protecting their forest is ($ 0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha/other _______):*

min($0) max($10) mean($3.37) sd($3.8)

6) *Without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.*
   Clear the land(18) cannot clear (19) protect form outside incursions(10)
   no response (2)

7) *Do you believe families have a right to water? (sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficient (20) twice sufficiency(1) thrice sufficiency(1) unlimited (4)
   no response (23)

8) *If it is a right, do you believe families have a right to water?*
   No(2) yes (0) no response(47)

9) *If water is both a right and a good, the point where it goes from being a right to becoming a good is at a level (sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficient(25) twice sufficiency(1) no response(23)

10) *Age:*
   min (15) max(71) mean(43) sd(13)

11) *Sex:*
   male(14) female(35)

12) *Number of family members:*
   min(1) max(8) mean(4.4) sd(1.4)

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All that glitters…

Further case study analysis of markets for watershed services in developing countries since *Silver Bullet or Fools' Gold*.

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All that glitters…

Further case study analysis of markets for watershed services in developing countries since *Silver Bullet or Fools' Gold*.

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1 Introduction

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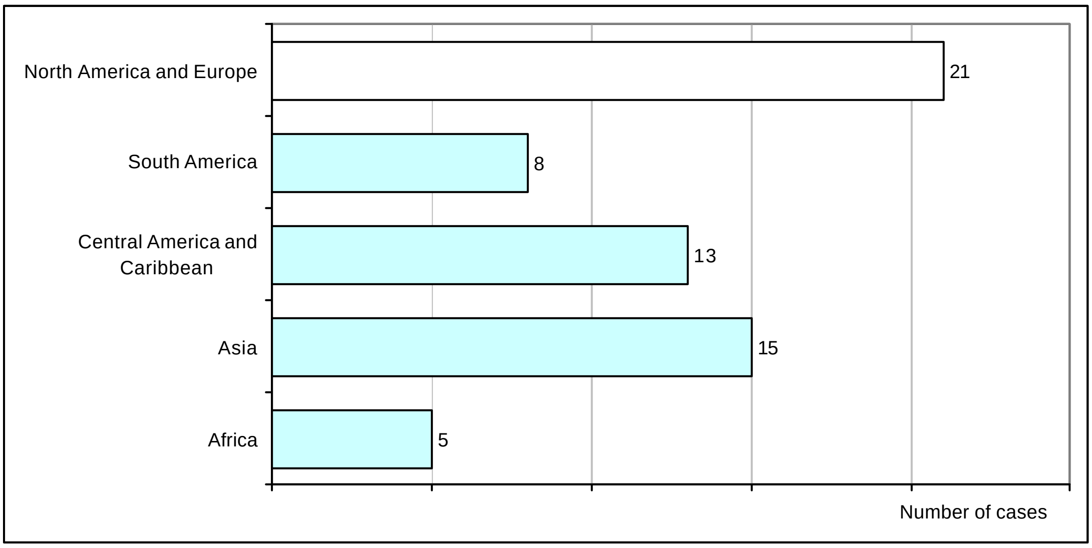
1.1 Why are we revisiting experiences?

In 2002 Landell-Mills and Porras reported approximately 60 cases of market-based mechanisms for watershed protection, with over 65% of them located in developing countries (see Figure 1).

Figure 1. Regional breakdown of watershed protection markets in 2002



Note: The total number of cases includes those reported originally as 'bundled'. Source: Landell-Mills and Porras (2002)

1.2 Key objectives, questions and methodology

This review undertook the task of revisiting each initiative reported by Landell-Mills and Porras in 2002. The main objectives of the review are:

1. Prepare a comprehensive review of all existing initiatives of markets for watershed services in developing countries.
2. Prepare a case profile (see section 8.1) format for the analysis and collection of information that guides the central questions of the review:
    a. What are the drivers behind market evolution?
    b. Who are the key players in evolving markets?
    c. How are the markets structured in terms of payment mechanisms, fundraising, timing and level of payments?
    d. How effective are existing markets in reaching environmental targets?
    e. What does market development mean for human welfare?
    f. Are existing markets efficient in economic terms?
3. Assess what has happened in emerging markets for watershed services after four years from the publication of *Silver Bullet or Fools' Gold*. This review has

classified schemes according to their development status as ‘ongoing’, proposals, borderline schemes, abandoned, or uncertain:

a. *Ongoing schemes.* These are initiatives in which payments are being made from the users (direct and indirect), suppliers, or both.

b. *Proposals*. Only relatively advanced proposals have been included in this review. This includes those with advanced baseline studies, stakeholders coming together in negotiation meetings, etc, but no payments are actually taking place yet. Some of these proposals take years to mature into ongoing projects, and this highlights the difficult nature of setting up payments for watershed services.

c. *Borderline schemes*. These are schemes where their market component is not clear. For example, it is difficult to distinguish the buyer from the seller in intra-village arrangements. Some of these schemes were included in Silver Bullet. However, this new review puts them in a separate category highlighting their significance as examples of fair deals but with no clear market connection.

d. *Abandoned schemes*. These schemes have been abandoned, either as a whole, or the environmental service component has been dropped for lack of support or leadership.

e. *Uncertain schemes*. It was not possible to obtain sufficient information proving that the scheme had been abandoned or was still ongoing. Some schemes may have evolved into another local or national programme (such as the Chinese regional schemes reported in 2002), but we have not been able to confirm this.

4. Draw out the most important lessons for constraints and promotion of markets for watershed services.

5. Make all the information collected available as a searchable engine on the Internet (www.watershedmarkets.org).

The analysis is based on a global review conducted during 2005 and the beginning of 2006. Collection of information is based on:

- Desk study of initiatives based on published and unpublished material, Internet searches, etc.
- When possible, direct contact with project organisers to fill-in gaps and provide detail of the particular schemes.

Each reference is annotated using Reference Manager. Each case profile is individually prepared as a .pdf document which can be downloaded from the website. Original profiles are in English. In the future the profiles will be available in Spanish and Chinese[1].

[1] Translations into Chinese are being prepared by the Department of Nature and Ecological Conservation, the State Environmental Protection Administration (SEPA) of China.

1.3 Constraints and information gaps

2 Setting up a definition for markets for watershed services

Conceptual issues
What sort of initiatives are we talking about – what we are including and why the MES/MMES/PES spectrum – highlighting differences (if any) from definitions/concepts used in the Silver Bullet report

Markets are defined as voluntary transactions between buyers and sellers, where the price is set on the basis of supply and demand. Even a first attempt at using this standard definition will nearly exclude all schemes in developing countries, especially when it comes to competitive price-discovery. This condition will be easier to track in auction systems (for example, salinity markets in Australia). Exceptions in developing countries will be land acquisitions to secure an environmental service, which in this review are considered more "borderline" market-mechanism schemes.

Taking into account previous definitions of markets and payments for environmental services (Pagiola (which one?), Robertson and Wunder, 2005), this study identifies market-based initiatives for watershed environmental services are those that are:

1. Voluntary transactions on the providers side *(note – otherwise it will be regulation)*

2. Between (a minimum) of one buyer and one-seller (that are distinguishable);

3. Conditional on previously agreed land use that is expected to provide an environmental service;

Additional desired conditions include:

4. Private sector pays for the provision of (previously considered) public goods;

5. Represent new sources of funding for watershed conservation; *(note: includes government re-allocation towards engaging with private farmers)*

6. Scheme provides some level of competition, which determines the extent to which individual stakeholders can influence prices (Landell-Mills and Porras, 2002). Competitiveness is associated with the number of participants. When there is fewer participants (i.e. monopolies or monopsonies) individuals will have more power and the market is less competitive. Effective participation is measured by the existence of barriers to participation.

2.1 Is participation voluntary?

Markets are defined as voluntary transactions. Although in the practice many schemes of watershed markets are indeed voluntary, there are examples where the condition does not hold. The voluntary component can be different for buyers or sellers.

In most cases, participation upstream is voluntary and the decision to engage in a scheme is determined by other factors (see CHAPTER ?? FOR DISCUSSION ON ENGAGING). Exceptions to this include:

- Government-imposed programme. For example, China's Sloping Land Conversion – although voluntary in principle, the selection of areas is done by the local government unit.

- Social pressure in intra-village agreements (ie. ICO in Bolivia).

- Hidden pressure of expropriation of private lands located in buffer zones of public parks (Campamento in Honduras, Social Forestry Programme in Indonesia)

- Hidden higher risk of eviction from public reserves: people living illegally in declared reserves face a stronger risk of eviction if they do not engage in best-management practices (examples in Philippines).

Participation from downstream users is mostly voluntary. Most of the funding until now comes from government budget allocations, grants from international agencies and in less degree (but growing) payments from the private sector. In the case of user-fees, water utilities make the decision after consultation with end-users (either directly through an open meeting for small schemes, or through willingness to pay feasibility and consultation studies, such as the case of the ESPH in Costa Rica).

An authority, usually the government, could also decide payments. In these cases, the end-user has little input in the decision. Examples include:

- Re-allocation of existing water charges and revenues (irrigation fees in Mexico, CPCJ Brazil, Plan Verde Colombia);

- Creation of new compulsory water charges for watershed conservation (Watershed Conservation Fund in the Philippines; new Canon de Agua in Costa Rica)

- Re-allocation of general or local budget government (fuel tax in Costa Rica)

2.2 There is at least one (different) buyer and seller

An important characteristic in a market situation is the existence of at least one buyer and one seller that are different from each other. The main exceptions to this include:

- Intra-village arrangements where it is difficult to differentiate buyers and sellers, as the project mostly concentrates on on-site services. Externalities might occur elsewhere, but downstream users are not included in the transaction. Examples of these include Arvari and Myrada in India; ICO in Bolivia.

- Internal-trading within the same organisation. For example, Desarrollos Hoteleros in Costa Rica purchased Certificates for Environmental Services from the Government to invest in their own private reserve.

- Land acquisitions by downstream users. These examples represent land-market transactions, and not environmental services deals. Once the downstream user (or donor) purchases the land, they become the user and the provider. ICO in Bolivia and Campoalegre in Colombia.

This differentiation means that several examples previously included in Landell-Mills and Porras (2002) are here considered as 'borderline' examples of watershed service deals. These examples are presented as interesting deals in watershed management, but they are not included in the general statistics for the analysis.

2.3 Payments are conditional on delivery

Conditionality assumes that payments are made for land use activities that will deliver an environmental service. Most projects aim at some degree of conditionality. However, in the practice, this conditionality is potentially restricted when:

- Payments are diverted to other activities not related to the environmental service provision. Examples include:
  - Most funding from the Watershed Conservation Fund in Philippines is diverted to short-term projects such as health and water supply and has a weak link with the provision of the environmental service.
  - Payments diverted to poverty alleviation in Maasin (Philippines) where people consider them as "something due to them".
- One-off transactions that result in immediate benefits that cannot be withdrawn or discontinued in case of non-compliance. At the moment, because most initiatives are quite new, it is difficult to assess if this risk is a real one in the long-term.
  - Social forestry in Indonesia. The main payment is tenure for 25 years that cannot be retracted. However, there is an initial 5-year conditional period as a trial period.
- One-off, short-term payments given to support transitional periods, where after payments stop the only guarantee to continue BMP is the expected on-site benefits to the farmer.
  - Payments for reforestation during first 5-years in Costa Rica (compliance expected for at least 20 years);
  - Switch to organic farming in Bhoj, India.
  - Orange orchards in Meijiang, China.
  - Shade-coffee in Sierra de las Minas, Guatemala; and Campamento, Honduras;
  - Silvopastoril projects in Colombia, Costa Rica and Nicaragua;
  - Cuencas-Andinas project in Fuquene, Colombia and Ambato, Ecuador.

Most initiatives are still at an early stage, and it is difficult to know if they will comply with the system. In all the cases, monitoring checks for compliance through visual changes in land use, rather than effects on water quantity or quality. Section **Error! Reference source not found.** will look in more detail at monitoring.

2.4 Are the sources of money new?

A 'promise' or expectation from markets for environmental services is that they mean access to new sources of money. Current sources of money include:

a) Re-allocation of (national and local) government general budget. For example, the Mexico National PSAH, which relocates money from irrigation to forest conservation; both China national projects; part of the funding for the Plan Verde in Colombia; and the Working-for Water in South Africa.

b) New local sources, including:

   b.1) Private investment (hydroelectric projects in CR, brewery), including contributions from parastatal groups.

   b.2) Additional user-fees (environmental fees in Heredia, CR, Juntas de agua in Central America), including user associations charges (Cauca Valle in Colombia)

   b.3) Stricter existing or new regulation for environmental services.

c) External sources, in the form of international grants (GEF, GTZ, SDC, IFAD, etc) and loans (World Bank)

2.5 Level of competition

The level of competition determines the extent by which individual players can affect price discovery. In general, it is possible to identify two basic types of mechanisms used for price discovery:

a) Administratively determined (non-negotiable) payments.

b) Negotiable deals through direct negotiation between sellers and buyers, negotiations through intermediary and trading systems (including auctions).

Section 5.3.2 looks in detail at the importance and use of these mechanisms in emerging markets.

2.6 Summary

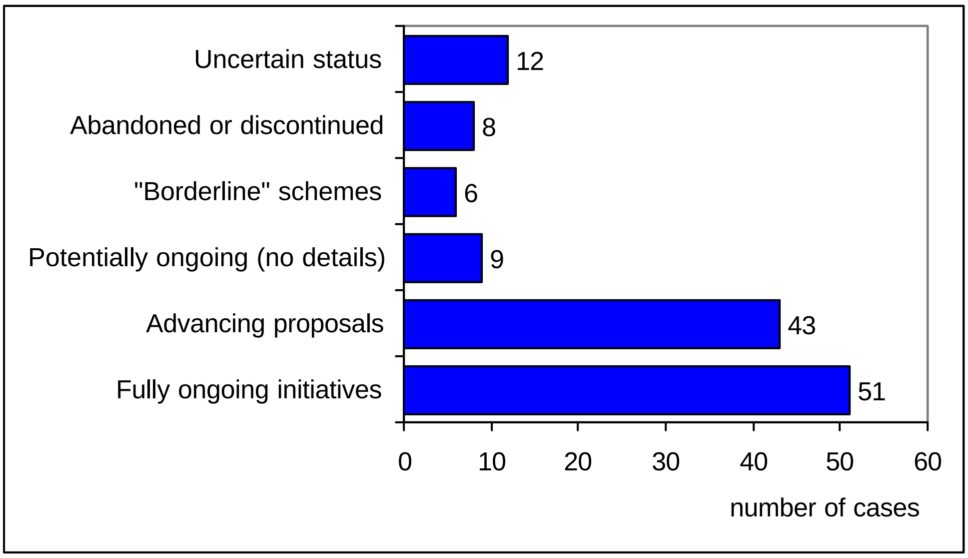
It is very difficult to find examples that fulfil the previous criteria.

We consider that the main criteria in these evolving market-based mechanisms are that buyers and sellers should be different. This means that several examples reviewed are hereby classified as ‘borderline’ and not included in the analysis of statistics. They are however included as ‘interesting’ examples of deals in watershed services.

Projects that have uncertain status, or those that have been discontinued or abandoned are not included in the analysis of evolution. From the advancing proposals (and potentially ongoing cases) there are seven examples well underway, and likely to become operational in the near future, and are therefore included in the analysis.

Statistics for the analysis in the following sections are therefore drawn from 51 ongoing cases and 7 advancing proposals.

Figure 2. Ongoing schemes of markets for watershed services in developing countries



3 Brief overview: general trends since *Silver Bullet or Fools' Gold?*

3.1 Status: many new cases but major setbacks

The interest in market-based mechanisms for watershed protection in developing countries has changed significantly in four years since the publication of Silver Bullet in 2002.

Development of schemes has not been easy (see Table 1). Out of the 16 proposals reported in 2002, only 4 of them are currently ongoing. Four years after 3 are still proposals, and 9 of them have been either abandoned, become something else, or it has not been possible to obtain further information about their current state. The same applies for reported emerging initiatives. Out of the initial 25 cases only 14 have survived and are reported as currently ongoing.

Some explanations for this poor performance include:

- Proposals (9 cases). Some of the proposals reported in Silver Bullet were at a very early stage did not evolve. For example, the international Bermejo-scheme alongside Bolivia and Argentina proved too complicated and instead several national schemes are happening in Bolivia. Some reported proposals were vague, like the Watershed Fund in San José in Costa Rica or Chagres in Panama (reported by Johnson, 2000), and did not materialise as formal proposals. In the case of Chile, the proposal for the PES-forestry component in water rights trading did not have support at the time, although water trading is happening. Major political instability has also halted efforts, such as the case of Integrated Catchment Management in Dryland areas in Zimbabwe.
- Emerging cases (11 cases). Some of the emerging schemes reported in 2002 referred to national-level programmes with a specific MES-related component that has not taken off. For example, the Stream-Flow Reduction Licences scheme in South Africa is still ongoing, but their marketable component reported in Silver Bullet has not evolved (as in the case of Chile). In other examples it has not been possible to obtain further information, such as the water boards in Malawi. Five cases reported for China (provinces of Jiangxi, Shiangxi, Hebei, and Northwest) have probably evolved into the national Sloping Land Conversion Programme.

Table 1. An evolving picture: what has happened since 2002

	2002	What happened to them?	New cases reviewed in 2006	Total cases reviewed
Proposals (including potentially ongoing)	16	▪ 9 abandoned or uncertain status ▪ 3 are still proposals ▪ 4 are ongoing	49	52 (49 + 3)
Emerging [(1)]	25	▪ 11 abandoned or uncertain status ▪ 14 are still ongoing	39	57 (39 + 14 + 4)

Total	**41**		**88**	**129** [(2)]

Notes: [(1)] Emerging cases in this table include 'borderline' schemes, to facilitate comparison with the 2002 review. They will be later excluded from analysis of market-based initiatives. [(2)] This figure includes the 20 cases reviewed that are abandoned or uncertain since 2002.

Despite the evidence for struggle, many new proposals and initiatives are emerging all over the developing world. This review was able to identify 39 new ongoing initiatives, which combined with those schemes reported in 2002 that are still happening (18 in total) brings a total of 57 ongoing initiatives.

Although the objective of the review was to look in detail at ongoing initiatives, it is impossible to ignore the large number of proposals in which the market component for environmental services is present. The review identifies 49 relatively advanced proposals. Some of these proposals are quite complete, with baseline studies developed and stakeholders already sitting at the negotiation table, but no payments have yet taken place and therefore have not been classified as "ongoing". Whenever possible detailed information about the proposals was collected, although such information was difficult to obtain in many circumstances.

EXPLAIN ABOUT FIRST/SECOND GENERATION HERE.

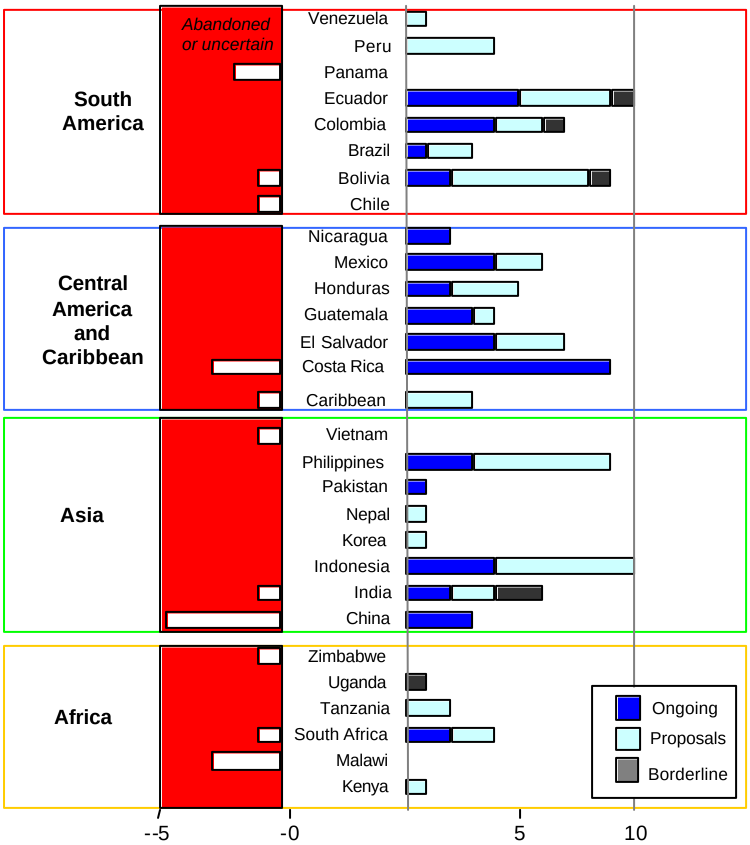
"First generation" schemes	Initial round of market for watershed services schemes. Most of them are local and relatively isolated pilot schemes characterised by a "learning by doing" approach". Most of the schemes reported in the initial Silver Bullet publication fall in this category.
"Second Generation" schemes	Schemes are slowly beginning to take into account existing experiences and lessons from other projects. Stronger emphasis is placed on the design of baseline studies, monitoring and information sharing. Many of these schemes are subsidised by donors and tend to be part of larger regional projects such as Cuencas Andinas or the Silvopastoral Project.

3.2 Regional breakdown of initiatives

Figure 3 shows the regional breakdown of markets for watershed service by region and country. Most of the schemes (pilot and ongoing) are located in Latin America, with significant interest in Ecuador, Colombia, Bolivia, and almost all the countries in Central America (except Belize). A large number of these proposals are donor-led, with significant involvement from the German and Swiss cooperation and the World Bank. Latin America has long history of strong organisational capacities, which facilitates the inception of local-based projects. (put this line somewhere else?)

There have been a lot of baseline work in Asia, especially in Indonesia and Philippines steered by RUPES, and major international groups like WWF, CARE and IIED are supporting initiatives in the area. This figure does not show the geographical extend of the initiatives, and therefore fails to show the extent of large national programmes in China, which could probably overshadow all the other schemes put together.

Figure 3. A snapshot of PES by country and status



Although there has been interest in carbon and biodiversity services, Africa has been lagging behind in terms of markets for watershed services. Only two cases in South Africa are properly ongoing (Working for Water and Working for Wetlands). There has been important work in other sites in South Africa, and the World Bank has recently approved a loan for XX millions to work in Lake Victoria in Kenya. Cooperation and exchange of interest and information is growing in the region. Recently Katoomba Africa was formed and information about environmental services for the region is posted in their website (www.katoombagroup.org/africa/pes.htm).

3.3 Geographical extend of markets: growing support from larger programmes

The scale of the projects vary, from the very local to large, national programmes. Most ongoing schemes are local and set at watershed level, although there is a marked emergence in national-level programmes and regionally coordinated programmes (see Figure 4).

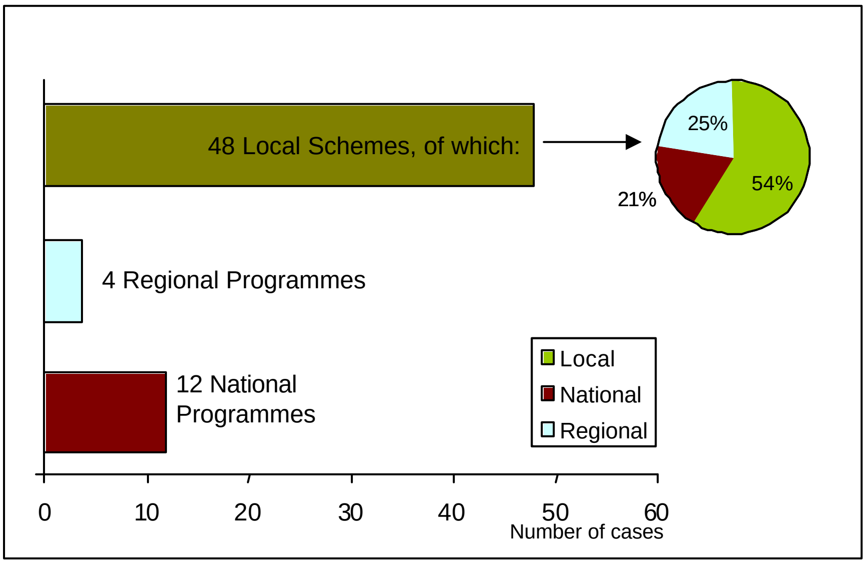
Almost half of the local schemes reviewed are part of a regional project (25%) or are developing alongside national-level programmes (21%). In all these cases, the local initiative receives financial and/or technical assistance in establishing negotiations among stakeholders, preparation of baseline studies, and design of mechanisms for collecting and allocating payments and general management of the scheme.

In some cases, such as Valle de Bravo in Mexico, funding from the national Payments for Hydrological Environmental Services programme came to boost the existing voluntary contributions to an environmental Fund created in 2000. In other cases, small local schemes such as those coordinated by PASOLAC in Nicaragua, El Salvador and

Honduras help create the momentum and base knowledge in order to upscale and create national-level programmes. Local schemes also emerge as part of national level programmes. For example, Coatepeque and Jaltepeque-Jiquilisco in El Salvador are pilot sites where the new national programme Ecoservicios is being piloted. In Costa Rica, the existence of the national-level PSA programme has provided the framework and institutional capacity to spur local-level agreements with several hydroelectric companies.

At the same time, over 50% of local schemes are emerging independently of a regional or national programme. Most of these schemes remain highly local, **XXX continue**

Figure 4. Geographical extend of markets for watershed protection



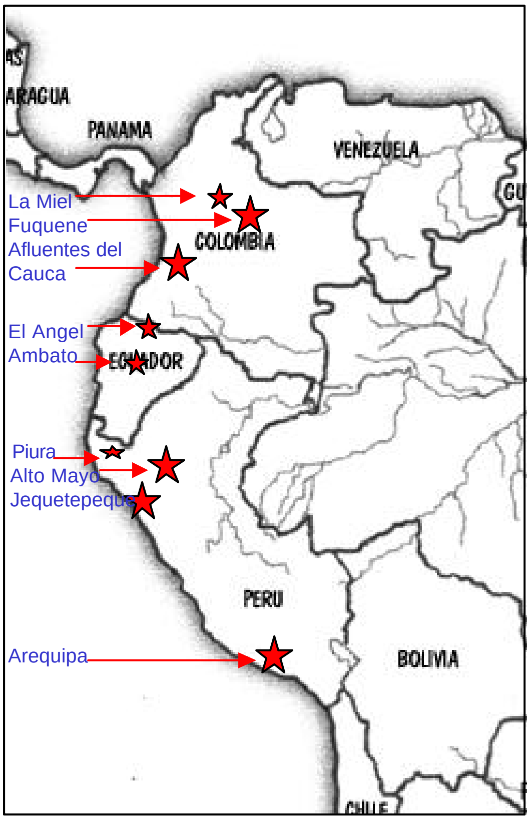
Regional programmes are not cross-boundary schemes. Instead, they are donor-led programmes that focus on particular areas (geographical and of interest). In general, these programmes aim at supporting "second generation" market schemes, in which proponents are beginning to take into account existing experiences and lessons from other projects and stronger emphasis is placed on the design of baseline studies, monitoring and information sharing.

International donors, such as GTZ, the World Bank, FAO, ICRAF and SDC, play a key role funding regional projects. The emphasis varies with the donor. For example, the Cuencas Andinas project, set in the Andean Region in South America, uses the following criteria for selecting participating watersheds: a) ecological-economic representative ness; b) presence of externalities, and c) possibility of strategic alliances with existing institutions.

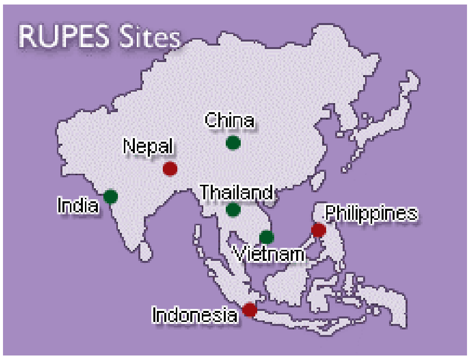
The Silvopastoral project is interested in improving the performance and reducing environmental impact of small and medium cattle farming by improving management practices. Payments for environmental services are used during a transition time to cover implementation costs and it is expected that improved productivity will sustain the land changes in the future. This project has a strong component of development of methodologies for technology adoption, identification of barriers to environmental-friendly systems, use and management of payments for environmental services schemes, as well as indicators and monitoring.

In the case of RUPES, in South East Asia, the emphasis is on poverty alleviation and they focus on marginalized communities in hilly and mountain areas. Active since 2003, the project has been documenting experiences on reward transfers, transferring and sharing information and promoting capacity building and baseline studies.

Figure 5. Cuencas Andinas Project Location



Souce: Based on Cuencas Andinas Website



Source: RUPES website

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OF PASOLAC OR SILVOPASTORIL SITES????

Table 2. Regional programmes in markets for watershed services

Programme Name	**Countries**	**Description**
Cuencas Andinas	Peru, Ecuador, Colombia	A GTZ funded project aiming at the promotion of sustainable land use in 15 watersheds in the Andean region of Colombia, Ecuador and Peru, through the creation of PES schemes among other management initiatives. The objective of the project is to implement innovative methods that can capture the potential for sustainable development, within these watersheds. The project will run for 8 years, and for the first stage (2003-2006), the objectives are to improve water management plans and implement PES schemes as a new institutional arrangement to manage the watersheds. The target groups are the technical and managing staff of the municipalities, local projects and NGOs, and the local communities.
PASOLAC (COSUDE)	Central America- El Salvador, Honduras y Nicaragua	PASOLAC, a branch of COSUDE (funded by SDC), is piloting 10 initiatives in Hounduras, Nicaragua and El Salvador through local municipalities. The important lessons for PASOLAC are the evolution of relations between stakeholders and the way in which Soil and Water Conservation technologies are introduced based on

Programme Name	Countries	Description
		contractual obligations between private farmers and water institutions. PES is a useful instrument to promote discussions among stakeholders and find solutions based on contracts and agreements.
RUPES (Indonesia, Philippines, Nepal)	Indonesia, Philippines and Nepal	RUPES (Rewarding the Upland Poor in Asia for the Environmental Services they Provide) is testing environmental service reward mechanisms in 6 sites: Philippines (Kalahan Reserve & Ancestral Domain and Bakun), Nepal (Kulekhani) and Indonesia (Bungo, Sumberjaya and Singkarak). In addition there are other "associate sites" where there is shared learning with partners but limited financial involvement from RUPES. RUPES is mostly funded by IFAD and they work alongside a consortium of international institutions.
Silvopastoral	Colombia, CR, Nicaragua	Funded by GEF and the World Bank, it aims at: i) evaluating the potential of silvopastoral land uses as providers of environmental services and socio-economic benefits for the communities; ii) developing incentives and mechanisms for payments for environmental services that would result in benefits for farmers and communities; and iii) providing policy recommendations about sustainable intensification livestock activities and PES.

The number of **national-level programmes** for environmental services has increased significantly since 2002, when the main projects reported were the Costa Rican PSA, Plan Verde in Colombia and South African Stream-Flow reduction Licensing Systems. At the moment there are 12 ongoing national-level programmes, ranging from the very large scale of the Chinese Sloping Land Conversion and Forest Ecological Compensation Programmes, to the relatively smaller Ecoservicios in El Salvador (see Table 3).

National-level programmes have advantages over small, scattered schemes. While they require significant levels of funding, they can also tap into government general budgets and access international funding in the form of donations or loans. National programmes have the (albeit changing) political backing required to make changes in the law that might facilitate collection of payments (see Section 5.4 for a discussion on legislation). The main drawbacks of national programmes are transaction costs and the lack of targeting. The time required to make such a transition could be very long and difficult, but the key remains in high-level political support.

Table 3. National Programmes for Environmental Services

Country	Programme Name	Description
China	Forest Ecological Compensation	INSERT DESCRIPTION HERE
	Sloping Lands Conversion Programme	Farmers must set aside erosion prone farmland within critical areas of the watershed of the two largest rivers in China: the Yagtze and Yellow river (sometimes called Huanghe river). Compensation is given in cash and in kind. Total investment is US$ 4.3 million a year.

Country	Programme Name	Description
Colombia	Plan Verde	National governmental forestry plan aiming at recovering forest cover while protecting micro-watersheds, regenerating areas affected by forest fires and degraded mangroves. Driven by the government's recognition of the need to protect the ecosystems that influence hydroelectricity production, drinking water supply and irrigation.
Costa Rica:	Payments for Environmental Services (PSA) Programme (conservation and reforestation)	Government led national scheme, ongoing since 1997 that rewards forest owners for protection of water, carbon sequestration, biodiversity protection and landscape beauty from forests. Most of the funding still relies in state funds derived from a fuel tax, with increasing participation from the private sector (especially hydroelectric projects). The programme will get significant new funding from the newly approved water tax, to be applied to all water users in the country. The National Forestry Fund (FONAFIFO) manages the programme.
	Certificates for Environmental Services (CSA).	A recently created mechanism designed by FONAFIFO to facilitate business' participation in the PSA scheme and capture funding beyond the already over-subscribed PES scheme. Each certificate represents one hectare of forest for conservation. The first stage of the CES is focusing on protection and regeneration of 7000 ha of forests in the Guanacaste area. Current buyers range from these local industries, to private individuals or foreign ethical investment companies.
El Salvador	Ecoservicios	This is a comprehensive World Bank/GEF funded project that aims at creating a national system of PES as a sustainable funding mechanism for conservation by i) establishing a functioning environmental services fund - FONASA (National Environmental Services Fund); and ii) designing a program of payments for environmental services, and providing technical assistance and monitoring contract compliance by the environmental service providers.
Guatemala	Direct Forestry Assistance Pilot Programme	The Ministry of Agriculture, Ranching and Food (MAGA) investing approximately US$0.5 million/year for protection of forest located in strategic water areas in Central and Western Altiplano.
Mexico	Payments for hydrological environmental services (PSAH) programme	Mexican country-wide scheme that targets areas of well preserved natural forest for protection of their hydrological function in critical watersheds and over-exploited aquifers and proximity to water sources that supply settlements of more than 5000 inhabitants, which might in the future take over the payment through their own local government and/or water utilities.
Philippines	Watershed Rehabilitation Fund.	Reforestation, Watershed Management, Health and/or Environment Enhancement Fund being managed by the Department of Energy (DOE) *to compensate* communities hosting energy projects. This is a government-imposed "social responsibility" compensation from electricity generation companies to host communities of such generation facility. Ongoing

Country	Programme Name	Description
		since mid 1990s.
South Africa	Working for Water and Working for Wetlands. Potential future projects include Working for Woodlands and Working for Fire (Christo Marais, personnal communication 2006).	Working for Water: the Department of Water Affairs and Forestry includes a water resource management fee in the price of water charged to consumers. This includes a charge for clearing alien invasive plants and for activities such as planning and implementation, pollution control, demand management, water allocation and water use control. Charges for clearing of alien invasive plants are levied in 13 of the country's 19 Water Management Areas. Working for Wetlands: Restoration of wetlands through government and industry subsidies.

key points

- A clearer definition of Markets for Watershed Services is presented (based on experiences);
- Not many are largely based on private investment;
- Initiatives with potentially more capacity of mobilizing funds are not voluntary on the buyer side (for example Mexico, Watershed Conservation Fund in the Philippines, Costa Rica –fuel tax and *canon de agua*);
- While potentially interesting as watershed management deals, intra-village arrangements, internal-trading and land acquisitions do not count as market-based initiatives for watershed services and they are not included in the statistics;
- Most projects aim at conditionality. Some projects have higher risk of non-conditionality, like those involving one-off payments (cash or in-kind) at the beginning of the project. Because most initiatives are relatively recent, it is difficult to establish if this is a real risk.

4 What is driving market development?

Without detailed information about the emergence of each scheme, it is difficult to pinpoint exactly what triggers the emergence of markets for watershed services. In general, the common factor in all schemes is related to inappropriate land management upstream, which is perceived affects the level of watershed services required downstream. The link could be real, backed by scientific studies, or based on common perceptions not necessarily backed by theory.

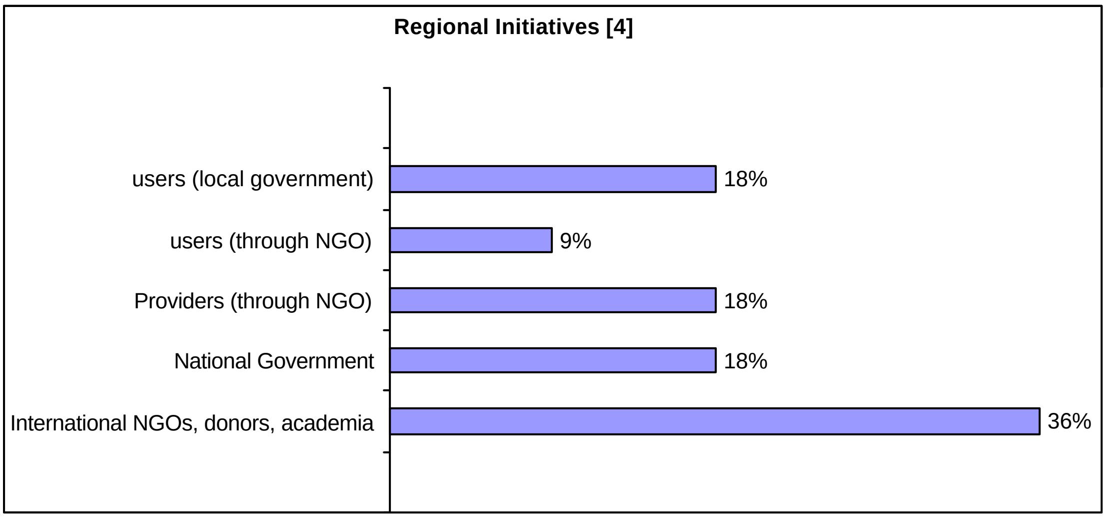
In this way, it is possible to identify two initial situations:

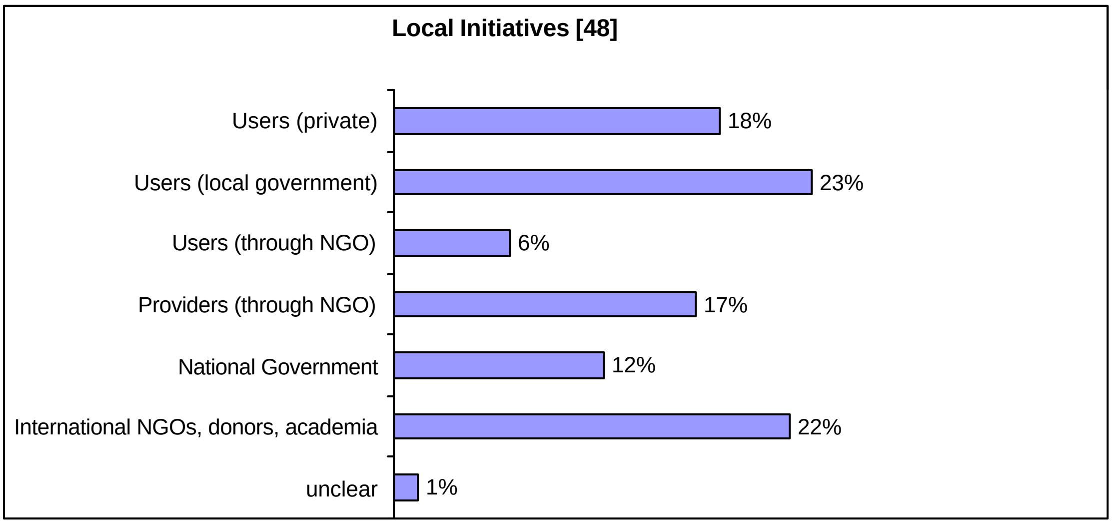
- There is a clear problem downstream with water services, and it is perceived that it is related to bad upstream resource practices (*demand led)*.
- There is inappropriate land management upstream (threats to conservation, degradation of resources) and a need to find funding to improve resource management. MES are perceived as possible sources of money *(supply led).*

It is very difficult to categorise all the schemes reviewed under one group or the other without falling in subjective grounds. In some cases, supply led projects are presented in a way that aims at convincing downstream users that they have (or could potentially have) a problem with the watershed service.

There are four potential proponents of market-based alternatives to address the problem. These include:

- User or provider driven initiatives (includes public and private groups)
- Government (national or local) drivers;
- Independent groups (NGOs, consultant groups, etc);
- Cooperation agencies (donors, banks, regional projects)





Situation 1: There is a clear problem downstream with water services, and it is perceived that it is related to bad upstream resource practices.

(deforestation, declining water quality, etc), which prompts downstream users/government/ to take action.

Proponents of MES

Case	**Water user** (public and private)	**Government-** national and local	**Independent group** (NGO, consultancy group)	**Cooperation agencies** (donors, banks, regional projects)	**Status**
Brazil (CPCJ)	X				On-going
Colombia (Cauca Valley)	X				On-going
Colombia (Fuquene)	X			X	On-going
CR (Energia Global, CNFL, Platanar)	X	X	X		On-going
CR (					

Situation 2: There is inappropriate land management upstream (threats to conservation, degradation of resources) and a need to find funding to improve resource management. MES are perceived as possible sources of money.

Case	**Provider** (public and private)	**Government-** national and local	**Independent group** (NGO, consultancy group)	**Cooperation agencies** (donors, banks, regional projects)	**Status**

Bolivia (Tarija)			X		Upstream implemented but no upstream paying
Bolivia (Los Negros)			X		On-going but no substantial downstream payments yet
Costa Rica (PSA)		X	X	X	On-going
Guatemala (Sierra de las Minas)			X		Negotiations
RUPES (Regional project)				X	Negotiations but no payments from users

5 What forms do markets take?

Driver
Service and Commodity
Sellers – size of landholdings, tenure, importance of agriculture/forest to livelihoods, extent of information given
Buyers – public or private, rich/poor, extent of information given
Payment mechanism

- how price level determined
- how funds transferred
- Payment terms – financial/non-financial, timing, conditionality

Role of intermediary
Role of ancillary service providers
Monitoring and enforcement /sanctions
Enabling legislation (not sure where this fits best)
Need something also on how they relate to other policy tools – are they used in combination with other water resource management and forest resource management tools and how?

5.1 What are the services and commodities marketed?

A key ingredient in a market is the commodity that is sold and bought. In markets for watershed services, this commodity is intrinsically linked to land use activities.

Adequate upstream watershed conservation (including forest protection) has spatially identified functions. Some of these are perceived on the same field or plot, but there could also be important downstream benefits including soil conservation benefits (such as reducing suspended sediment yield), and water related benefits, such as the contribution to total water yield or reduction of flood damage in small events. The effects, positive or negative, can in turn have economic consequences for downstream water users. While available rainfall is an external variable determined by climatic conditions, Van Noordwijk (2003) suggests three main watershed services based on "hydrological outcomes" that can be influenced by land use:

- Changes in quantity or total water yield;
- Evenness of flow. This implies higher flows during the dry season, and reduction of peak flows during the wet season. However, the degree of 'buffering' that can be attributed to land use decisions (rather than climatic events) needs to be clearly established. Effects also depend on the location of the 'observer' or user within the watershed. Effects from land use changes will be evident up to a 100km2, but after that the effects tend to be diluted. Also, riparian vegetation plays an important role by filtering soil erosion and man-made pollutants, regulating the water temperature and oxygen concentration, reducing channel bank erosion and by serving as biological corridors. On the other hand, trees and debris from riparian vegetation may cause local flooding by creating blockages during storms.
- Changes in the quality of the water. This has direct results over domestic water uses (such as drinking water), industrial use, irrigation, and as habitats for biodiversity.

The relative importance of the watershed service depends on the on-site conditions, the direction of a land use change, the type of water users and where are they located along the watershed. There might be cases of conflicts of interests, but also potential for collaborative work. For example, some users might be more interested in reduced sedimentation, or higher dry season flows. Table 4 presents some examples of the type of services demanded by water users.

Table 4. Description of hydrological service by end user

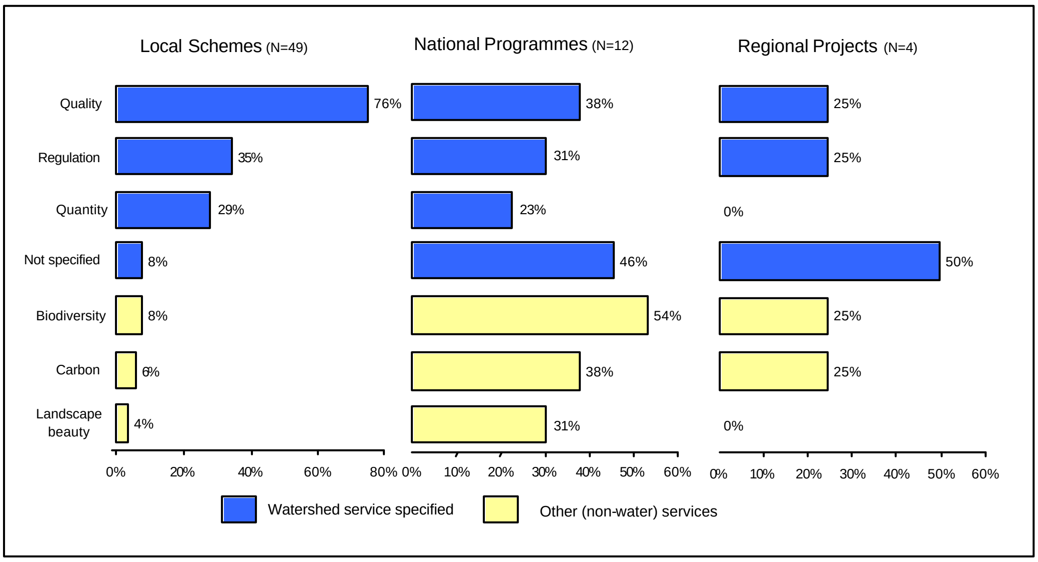
Water user	**Service Demanded** **Quantity**	**Quality**
Hydroelectric projects		
Annual and Intra-annual reservoirs	Maximum water supply throughout the year (seasonality not so important). The impact on total water yield may be small unless the areas with improved land use are large.	Reduced sedimentation - the importance of which depends on the reservoir capacity to accommodate sediments.
Daily reservoirs projects	Maximum daily supply, especially during dry seasons when rainfall is limited	
Run-of-river	Maximum water retention in the watershed to provide constant flow throughout the day. Changes from soil quick flow (saturated forest soils) to overland flows will have some effects on buffering river flows and hydroelectric operation.	Reduced sediments and waste that can affect the turbines.
Population centres: Urban and rural residential water consumers *(through municipal and private water utilities)*	Constant water supply throughout the year for drinking (i.e. 150lt/day/pc); Reduced flood risks in the wet season and water shortages in dry season.	Improved water quality especially in catchment areas that reduces treatment costs.
Disaster relief agencies	Reduced risk of floods	
Industrial Water Users		
Agricultural sector: Irrigation projects, farmers, agricultural markets	Constant flow of water - especially in dry season - for agriculture. Reduced risk of floods	Water quality in terms of toxics, salinization, etc.
"Wet" industry		
Distilleries, film processors, microship manufactures, food processors,	Constant flow of water throughout year	Reduced contamination of water
Commercial fisheries, sport fisheries, fishery management agencies, etc		Reduced contamination of water. Reduced aquatic productivity and destruction of coral.
General industry		
Transportation	Constant flows throughout year	Reduced siltation of harbours, rivers and waterways
Tourism	Water available throughout year, especially dry (tourist) season	Improved water quality, reduced degradation of tourism sites
Insurance companies	Reduced risk of floods	
Ecological flows (i.e. wetlands)	Availability of water flows especially in dry seasons.	Reduced siltation, sedimentation, suspended toxins from agriculture etc

Source: based on The Conservation Finance Alliance (2002), Landell-Mills and Porras (2002), and Van Noordwijk (2005).

The linkages between land use and watershed services are not straightforward, and in many schemes are based more on perceptions than scientific rigour. Chapter **Error! Reference source not found.** presents a discussion on the water impacts of land-based projects and how emerging watershed markets might result in better provision of environmental services, and Box 1 presents a 'check-list' of land-water relationships.

Water quality is top priority for the majority of ongoing local schemes (see Figure 6). Regulation of flows, such as droughts and flood control, is expected in 35% of the cases, and almost 30% of schemes claim or expect that land-use activities will increase water quantity. There is a noticeable practice of targeting specific watershed services, rather than being vague in the delivery of the watershed service (as it is the case of national programmes or regional projects). The reason is simple. Downstream users will pay if the scheme is clearly specifying that the service they demand will be provided. Whether this happens or not is discussed in Chapter **Error! Reference source not found.**.

Figure 6. Summary of watershed services demanded



Note. The statistics shown in the graphics represent the environmental services specified in project documents. The selection of each service is not mutually exclusive, and each scheme might try to pursue several environmental services at the same time.

National programmes, on the other hand, tend to have a more spread-out approach to environmental services. Most of these programmes aim at producing or protecting multiple environmental services, and this reflects their intention to tap into multiple sources of funding (for example, from carbon sales or biodiversity groups). The danger of some national programmes is precisely their lack of targeting specific watershed services, and could run the risk of not responding to local demand. Regional programmes tend to be more vague, although the level of clarity increased as the programme gets local through specific schemes.

Box 1. 'Check-list' of land-water relationships

A key challenge to the development of market-mechanisms is the 'packaging' of the environmental service. This step is necessary to make the service 'tangible', both for users and providers. A solid scientific base is very important, but so are the perceptions that stakeholders have of the impacts of their land use decisions (see Porras and Miranda, 2005, for more on perceptions). This is especially applicable to service providers, as complicated commodities (such as credits) will have limited applicability in areas with problems with information flows and limited general capacity. At the same time, the choice of the commodity and the marketing mechanism will be ultimately affected by the local administration capacity, and it must reflect a careful balance between definition and management costs. The use of complex commodities, such as credits and transferable licences is mostly used in developed countries such as USA and Australia.

Because it is easier to track and manage, projects in developing countries follow a land-based strategy, which implicitly assumes that a particular type of land use will provide a set of environmental services. There are other practical advantages. Land-based units are easily understandable by farmers, policy-makers and water users. Table 5 presents several examples of schemes, environmental problem, environmental service pursued and their associated commodities.

The definition of the commodity is linked to previous experiences. It is easier to build upon existing capacities rather than introducing completely new concepts, as most countries have previous experience in soil and water conservation projects. This 'legacy' can be positive; taking advantage of created knowledge through learning-by-doing, but could also carry on 'old baggage' from dominating policy groups. For example, strong support for reforestation for commercial purposes comes from forestry lobbies that do not necessarily have to do with water provision.

The main commodities for commercialising watershed environmental services in developing countries are:

(1) Best-Management Practices:

These practices are being proposed by project planners as ways to generate medium to long-term on-site returns to the farmer. The payment for environmental service might come in the form of initial funds, technical capacity, seedlings, etc, to help the transition and initial conversion costs. The long-term incentive is presented as higher yields from crops, or access to niche markets in the form of environmental-friendly products through certification schemes. Some of the practices used include:

- Improved agricultural practices (alternatives to slash-and-burn, soil conservation land techniques, organic farming or low pesticides; integrated pesticide management);
- Agro-forestry (shade coffee);
- Improved ranching management (including silvopastoral);
- Sustainable forest management. As opposed to the previous practices, SFM might not result in higher profits in the medium and long-term, as they face management restrictions. The incentive comes in the form of access to a resource that would otherwise be totally restricted (in places where legislation prohibits forest conversion or in public lands), or access to niche markets through certification such as FSC.

Examples include concessions from public forestland, sustainable management of existing private forests, etc.

(2) Reforestation for commercial plantations

While this could be considered as sub-category of best-management practices, forest plantations tend to include monoculture or use exotic plantations that might not be necessarily considered best-management practices from a water service point of view.

Plantations could have negative effects in terms of reduced water flows and biodiversity (if monoculture).

(3) Conservation and protection of existing ecosystems

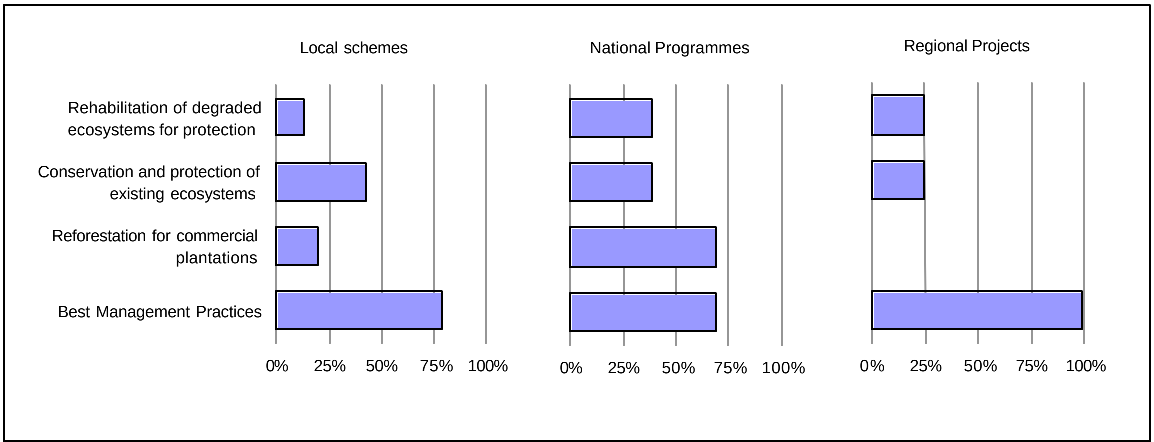
This category refers to the prohibitions or restrictions of use of existing ecosystems. For example, avoiding conversion of forest conversion to other land uses, protection of riparian areas; and protection of strategic water recharge areas.

(4) Rehabilitation of degraded ecosystems for protection

The promotion of activities leading to recovery or rehabilitation of degraded ecosystems that will provide environmental services. It is assumed that these recovered areas will be protected afterwards. Incentives are given to support restoration costs. In some cases there can be a flow of payments for protection afterwards. In other cases they can be given to comply with legislation requirements (for example, where initial conversion was illegal).

Figure 7 presents a distribution of the commodities promoted in ongoing markets for watershed services. Best-management practices are by far the most popular commodity promoted in ongoing initiatives regardless of their scale. They were reported in 80% of local schemes, 70% of national programmes and in all the regional projects. Best-management contracts are regarded more appropriate towards long-term sustainability by avoiding 'exclusion' activities (such as protection), supporting livelihood activities in more appropriate ways, and by making the new activity attractive enough so that the farmer will continue indefinitely. Best-management contracts are usually linked to fixed-period payments, either in cash or in-kind as technical assistance, aimed at 'tipping the balance' between current and desired land uses (Pagiola *et al*, 2004).

Figure 7. Commodities in markets for watershed services



Note: Some projects present a combination of practices.

'Exclusion' activities, such as conservation and protection of existing ecosystems (usually forests) are reported in over 40% of local schemes and national programmes. Many of these activities aim at protecting remaining patches of forests, perceived as key elements in the provision of downstream water services. For example, all watershed projects in Costa Rica (hydroelectric projects CNFL, Platanar, Energía Global, ICE, and La Esperanza, and water-based companies ESPH and La Florida) aim at increasing or protecting forest cover as means to reduce potential sedimentation and reduce flash floods.

Water quantity is not explicitly written in any of these cases, as regular precipitation is usually high. There are however many cases where it is expected that protection of existing ecosystems will result in water security. For example, two communities in El Salvador are paying through user fees for “water provision and quality” provided by El Imposible National Park (Rosa, Kandel and Dimas, 2003). In the local scheme of Los Negros, in Bolivia, downstream farmers perceive that water flows have reduced by more than 50% in the last two years as a consequence of deforestation of the cloud forest (Natura, 2004), and they expect the situation to stop by encouraging the protection of the remaining forests. National programmes like the PSAH in Mexico and the PSA in Costa Rica specifically target conservation of forests as means to deliver watershed services alongside other services such as biodiversity protection and landscape beauty. In the case of Costa Rica, the high emphasis on conservation also arises from the farmers, as conservation implies lower initial investment than other activities such as reforestation or agro forestry.

Table 5. Examples of watershed services and associated commodities

Identified problem	Service proposed	Commodity	Place
Deforestation causing erosion and siltation into Brantas River	Improved water quality	Rehabilitation of degraded areas through tree planting at pilot sites	Brantas, Indonesia (LPT3-IIED)
High levels of agro-chemicals in Bhoj wetlands and Lake	Improved water quality	Best management practices through switch to organic agriculture	Bhoj Wetlands, India
Soil erosion and siltation of proposed dam, low dry-season flows	Improved water quality and quantity	Best management practices through soil conservation and zoning	Bhodi-Suan, India
Sedimentation in lake providing water for downstream town	Reduction of sediments in Lake	Best management practices through soil conservation techniques, use restriction through reduced grazing intensity and tradable water rights.	Sukhomajri, India
Deforestation of cloud forest reduces water quantity	Improved water quantity and reduced sedimentation	Protection of existing forests	Los Negros, Bolivia
Loss of biodiversity and critical ecosystems. Poor water management, problems with dry-seasons and floodings, landslides, declining water quality.	Biodiversity protection, carbon sequestration, regulation of water flows and quality, reduction of environmental vulnerability to landslides, scenic beauty	Protection and restoration of existing forests	National programme EcoServicios, El Salvador
	Regulation of water flows and quality, reduction of landslide risk, scenic beauty, carbon sequestration, biodiversity protection	Best management practices through combining trees with agricultural production (agroforestry, silvopastoral practices, shade coffee, live fences)	

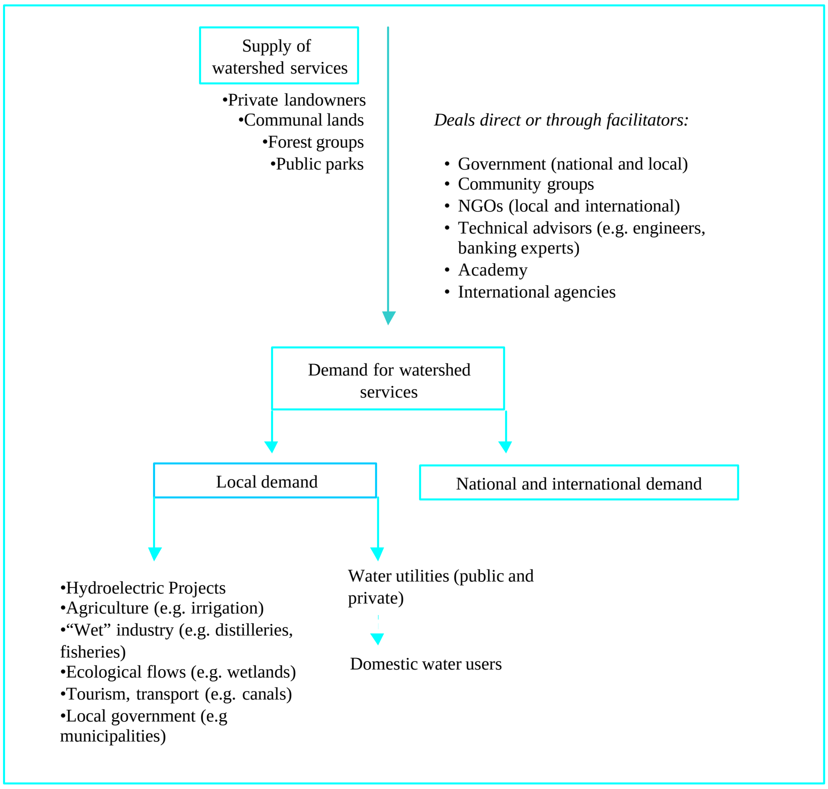
	Regulation of water flows and quality, reduction of landslide risks.	Best management practices in agricultural land (mulching, low tillage, live barriers, conservation works)	
Degradation resulting in compaction of soils and decline in infiltration leading to low dry season flows.	Protection, conservation and management of strategic water sources.	Best management practices mostly through soil and water conservation techniques in small watersheds (no slash-and-burn, management of crop residues, natural regeneration of forest through selective logging, management of coffee farms, conservation of forest, use of wind-barriers and life fences, and use of coffee waste for compost	PASOLAC, 10 initiatives in small watersheds in Central America
Deforestation and loss of ecosystems	Improved water quantity and quality	Conservation of existing forests and reforestation	Mexico (national programme)
Deforestation and loss of ecosystems	Improved water quantity and regulation	Mostly conservation of paramo and natural forests, but also some improved agriculture measures.	Pimampiro, Ecuador
Deforestation threatening water supplies and siltation of reservoir	Reduction of sediments and improved water regulation	Mostly conservation of existing forests and prevention to conversion.	Platanar, Costa Rica

5.2 Characteristics of the participants

The potential key players in markets for watershed services are presented in Figure 8. The main groups involved in emerging markets are:

1. Those providing the service;
2. Those demanding the service;
3. Facilitating individuals or groups that help bridge the gap between supply and demand, and support the design of the deals.

Figure 8. Who are the key players?



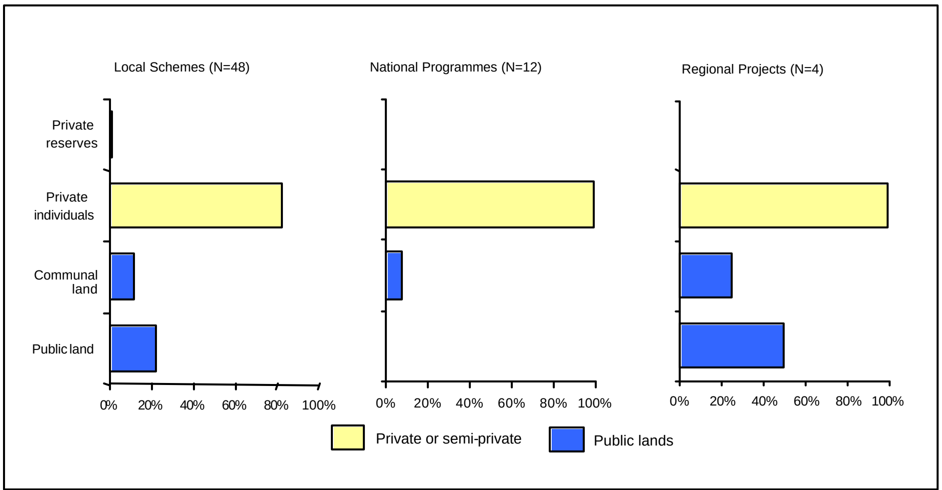
5.2.1 Providers of watershed services are mostly private

Service providers are those stakeholders with a contractual relationship with those groups who demand watershed services, who commit themselves to implement previously agreed land conservation practices in their landholdings (specifically in the water recharge area). Potential service providers are those with land in the target areas but without any contractual relationship with users or intermediaries (Kosoy, *et al*, 2005).

This review identifies four main categories of suppliers:

- Private landowners: They have clear ownership of their land, with either land titles or undisputed possession rights.
- Public lands: This group represents farmers living in public land (usually declared as national parks or protected areas, sometimes called "paper parks"). Farmers usually do not have possession rights.
- Communal land: Farmers living or drawing their livelihoods from communal land. This includes the *ejidos* in Mexico.
- Private reserves: private landowners (individuals or groups) registered as reserves and committed to conservation of specific ecosystems.

Figure 9. Participants in markets for watershed services: SUPPLY



Note. "N" represents the population of schemes with sufficient information for this field.

Watershed markets mostly target private landowners as their main suppliers (see Figure 9). Because of their ability to respond to local conditions, local schemes can be more flexible about land tenure, and while private property is still the main group, other forms of tenure are present, such as farmers living in public lands (23%), or communal lands (13%). The same applies for national programmes. The only exception is the Mexico National PSAH programme, where communal land ownership (*ejidos*) is the main form of land tenure (see Box 2). Although these programmes have been severely criticized for this policy, (see Box 3), the complications arising from monitoring at national-level monitoring would escalate if property rights are unclear and a level of trust in delivery cannot be achieved.

Box 2. Dealing with common property in Mexico

Box 3. Property rights and market for watershed services

The reliance on private property tends to leave out poorer groups that depend on communal land for their livelihoods. These groups are now being specially targeted by regional projects, such as Cuencas Andinas in South America and RUPES in South East Asia, which experiment on the conditions under which market structures could overlap with social land tenure.

Property sizes vary depending on the country, and the concept of small, medium or large ownership is extremely relative. For example, the project of Los Negros in Bolivia works with 13 private landholders, holding property sizes that range between 3-390 hectares, and so far covering 1100 hectares of cloud forest (the aim is to have 2500 hectares under compensation and 500 hectares as community water conservation reserves). In Pimampiro, Ecuador, approximately 20 families receive payments for environmental services for 638 hectares of forests and shrub lands.

Central America is characterised by small-sized properties, which increases the challenge of achieving a threshold to deliver the environmental service. By 2004 the local pilot scheme in Jesus de Otoro, Honduras was working with 18 farmers, covering almost 80 hectares in a 3180 hectares watershed. In three small pilot schemes in El Salvador (Yamabal, Tacuba and Chalatenango), working with the regional NGO PASOLAC, farmers have an average property size of 2.5 hectares. In the national PSA in Costa Rica minimum and maximum property size to participate in the programme is 2-300 hectares (600 hectares for indigenous reserves) for forest conservation, and as small as 1 hectare for reforestation. The eligibility requirements vary from geographical and physical (location with respect to protected areas or biological corridors and land suitability for forestry activities, to social and institutional (areas with low Social Development Index are prioritised, and international donors can choose their target areas).

Projects working in communal lands and public areas tend to include larger numbers of participants. For example, the Tarija project in Bolivia targets farmers living inside the Sama Biological Reserve. The status of the reserve permits human habitation and exploitation of the resources, and includes 25 communities with a total of 4000 inhabitants. It is perceived that the continuation of the current land use, involving further deforestation through uncontrolled burning and degradation of natural grassland and shrub lands will have adverse effects on dry-season ?ows (Robertson and Wunder, 2005). In

5.2.2 Demand for watershed services is largely public

Demand for watershed services comes from local, national and international sources.

Local sources of demand are mostly service users. It includes individuals or groups either consuming watershed services as a final product (i.e. domestic water users), using them as inputs for their production process (i.e. hydroelectric, irrigation, beverages, mining, pulp, etc), or depending on certain levels of services for environmental purposes (wetlands or conservation groups). In the case of domestic water user, end-users are represented by a water utility (private or public).

National and international demand for watershed service is another important group. It provides funding from government and international agencies. Most of these groups are interested in a wider range of environmental services, such as biodiversity. International agencies can play a key role in providing conservation or development grants to pilot schemes until downstream groups adopt payments. Alternatively, national government may wish to pool service buyers in the public interest for strategic watershed services that cannot be realistically financed by downstream demand. The Costa Rican PSA programme, the South African Working for Water programme and the Chinese Sloping Land Conversion Programmes are examples of upstream payments being wholly or partly funded nationally for improved or protected public goods' provision.

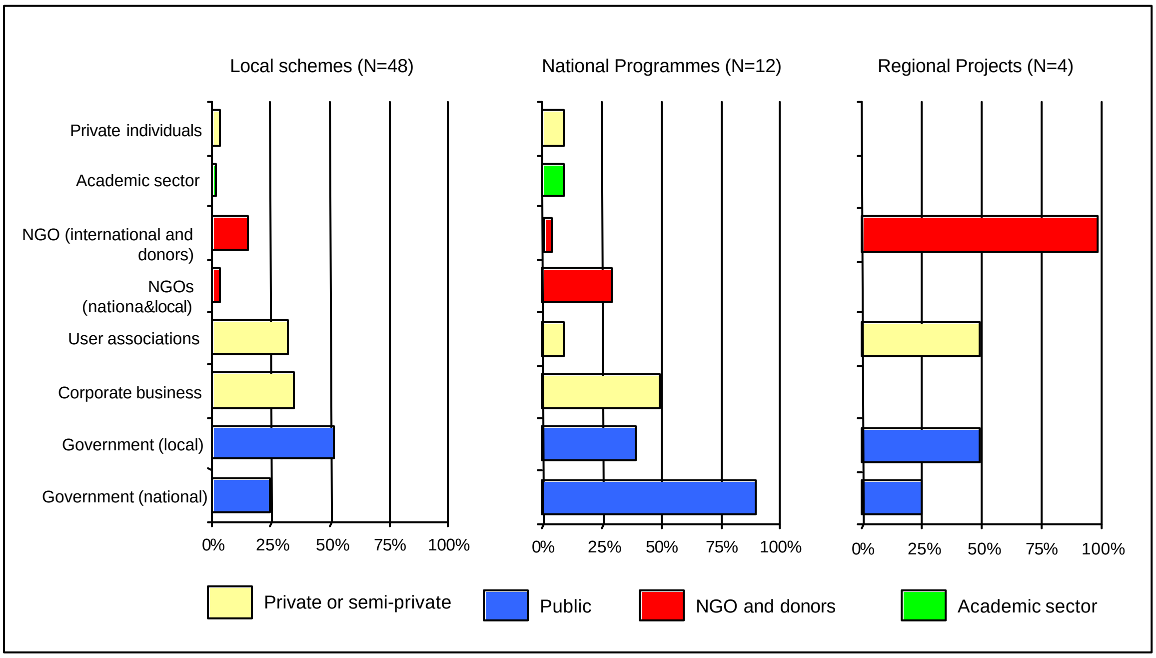
The importance of national and international contributions increases when:

- The link between service demand and service supply is not locally defined. For example, potential benefits have a different scale such as groundwater recharge or biodiversity conservation;
- Downstream demand and/or ability to pay is low, and the upstream areas are of particular national interest or importance;
- Downstream users are already heavily taxed and the Government agrees to allocate some of these funds to watershed payments;

Figure 10 shows the character of the demand in watershed markets. While supply of watershed services remains mostly a private deal, demand for services relies heavily on the public sector. Participation of the private sector has fallen behind initial expectations. Although private water users indicate a perception of the links between deterioration of upstream natural resources and downstream water impacts, securing their monetary support has been challenging.

Local schemes are actively targeting local users for funding. Half of the cases reviewed focus on one large user as source of funding (25% corporate business or user associations, and 25% local governments or municipalities), although most of them are negotiating payment terms with other groups. Only two cases rely completely on national sources of funding, and the remaining schemes presents a combination of private, public and international sources of funding.

Figure 10. Participants in markets for watershed services: demand



All national programmes (with the exception of the certificates for environmental services, CSA, in Costa Rica, which targets the private sector) are funded from national government budget. Funds come from specifically created taxes on water users (such as new user fees in the ESPH in Costa Rica, Pimampiro in Ecuador, and Fideicoagua in Mexico, diverting funds from existing water-related charges (for example, the Watershed Rehabilitation Fund in the Philippines and the Mexican PSAH, which redistributes funds from irrigation charges), or from general government budget (for example, the Chinese Sloping Land Conversion Programme and the national programmes or the Costa Rican PSA programme[2]).

Box 4. Pooling demand for watershed services: an example from Costa Rica

International NGOs, groups and donors play a key role in demand discovery. All regional projects are funded by international sources, although the local schemes they support look for local sources of funding for long-term payment systems. At national-level, international funds are sometimes combined to target specific regions or other environmental services of interest for the donor. For example, funds from KfW targeting a specific biodiversity-rich area in Costa Rica are combined with national funds to enlarge the target area and provide a larger volume of several environmental services, including water protection. International funding usually comes in the form of grants or loans. The World Bank, for example, has been making loans to several countries to develop their national payments for environmental service programmes (see Table 6).

The low level of participation of international donors depicted at local level in Figure 10 could be misleading. International donors are a very important source of funding, but in most cases their contributions are channelled towards design or management of the

[2] The Costa Rican PSA programme received for several years earmarked funding equivalent to 3.5% of fuel tax collections. Commitments from the government change with each new administration, and current funds come from general national budget.

scheme, rather than direct payments as this figure shows. Often, international donors tend to see their contributions as temporary, supporting nascent and emerging schemes until they are able to secure local sources of funding (Hartmann and Petersen, 2004).

5.2.3 Facilitating groups play a key role

Negotiations between providers and users can be direct or with assistance from facilitating groups.

Direct deals account for almost 20% of local schemes, and usually happen when there are few stakeholders with enough power to negotiate with (usually few) upstream landowners. For example, La Esperanza in Costa Rica is a small initiative where a hydroelectric company entered a contract with a private reserve protecting cloud forest upstream. In this deal, the hydroelectric company was keen to strike the deal as means to secure land access to build a small dam. In other cases, a water utility will negotiate with upstream farmers on behalf of their final end-users. Usually, the utility has the power to make decisions, sometimes following some kind of consultation. Examples include the ESPH in Costa Rica, the CPCJ scheme in Brazil, where two municipalities are paying to establish nurseries and for restoration of forests along riverbanks and other critical areas. In some cases the water utility charges additional fees to their final users, in others they allocate existing funds. Section 0 looks in detail at the sources of funding.

There are different types of facilitators helping to broker deals. In some cases the tasks can overlap, and one group can do several tasks (for example, dialogue brokers and administration facilitators). Some facilitators can also have a transitory character, for example, assisting during the initial stages of the schemes (facilitating dialogue or information) but fading away as the scheme gathers strength and other institutions or groups take ownership. The main types of facilitators identified are:

- **Dialogue brokers** are those groups that help create the spaces to encourage dialogue between farmers and downstream users. Their participation could be transitory. The dialogue will help to identify the environmental services expected by downstream users.
- **Technical advisors** are in charge of programme design. They are in charge of developing management plans and establishing monitoring systems to ensure the delivery of watershed services. This group requires biophysical, legal and social scientists, as well as technical experts for the design of maps, computer programmes, GIS-based systems, etc. One of their jobs is to maximise downstream service buyers' demand by identifying sellers who will deliver the greatest improvement in services at the lowest cost.
- **Technical advisors rural extension** experts support farmers and helps create the technical, social and institutional capacities to actually implement the plans. Design and implementation are closely related, and methods to allow feedback should be in place.
- **Financial facilitators** are those groups provide funds to initiate negotiations and develop baseline studies. Some of the major international funding agencies include the World Bank, the Global Environmental Facility (GEF) and IFAD.
- **Administrative facilitators** are those individuals or groups in charge of the actual administration of the scheme. They will collect and allocate funds, coordinate

overall monitoring and technical capacity. They define contractual terms and manage financial exchanges to reduce transaction costs, increase trust and transparency and fill any institutional gap. Some national programmes also use trust funds, usually required by international donors in order to administer specific grants. Trust funds are increasingly used in South America, especially in Ecuador, where significant capacity building has been created with the experience of FONAG in Quito (see Section 5.3 for a discussion on mechanisms to administer funds). Regional projects are administered by local or international NGOs, but the local schemes they support have strong connections with the local governments.

- **"Wholesale" managers**. In these cases, a facilitator will take the risk of the intermediation process by buying the environmental services (usually bundled) from landowners. They will try to sell these services to different users by pooling demand from local and international sources. This type of intermediary in the practice becomes a 'first-stage' demand for environmental services. This is the approach done by FONAFIFO, in Costa Rica, which administers the national PSA programme (see Box 4).
- **Information facilitators**. These are groups at national and international level that support and facilitate the flow of information, lessons, materials and contacts. It includes international research institutes and groups and universities. Examples include the advisory role played by IIED, the Katoomba Group Ecosystems Marketplace, RUPES, IUCN, GTZ, FAO, etc.

Intermediaries are generally effective in reducing transaction costs and risks. Their capacity will directly affect the degree of sophistication of the mechanism for transferring funds to choose. For example, setting up trust funds requires long-term commitment and careful legal and financial considerations. It is also the responsibility of the intermediary to guarantee service delivery. This is usually done through targets, monitoring, and the provision of technical support. The intermediary either has the capacity to do all this, or they contract out services from other groups.

Box 5. Allocating roles and responsibilities

5.3 Payment Mechanisms

This section presents a review of the main issues related to payment mechanisms in incipient markets for watershed services. It focuses on four main areas:

1. Where does the money for payments come from?
2. How are payment levels determined?
3. How are payments transferred from buyers to sellers?
4. What is the unit (cash or in-kind) and timing (one-off, ongoing) of payments?

The Heredia PES project in Costa Rica used a combination of opportunity cost to estimate 'capture values', and substitutes costs to estimate the cost of protection and recovery of forest. These values suggested an upward revision of 7.59 colones/m3 as a water fee (tarifa hídrica). The national regulating body authorised an increase of 3.8 colones/m3.

A 2003 survey in Los Negros, Bolivia, showed that 70% of downstream farmers would be willing to pay approximately US$12500-US$19700 per year, equivalent to 2% of average household income (Robertson and Wunder, 2005). It took some time to overcome mistrust and by 2006 it is expected that the municipality and downstream users will be paying approximately 60% of the project costs (Vargas, personal communication, 2005.

Useful valuation exercises will provide an initial reference point, or range of values to help guide the negotiation process. These values should be cross-examined and strengthened with other information (such as local narratives, policy changes, livelihood analysis). This information might help stakeholders and policy-makers arrive to a negotiation table with their own defensible views about market and non-market values. More effective decisions could be then achieved from a well-informed bargaining process. However, economic valuation in general, and particularly for watershed services, can be limited by the following problems: (Porras, *forthcoming*).

- *It is very difficult to establish the biophysical linkages of land use and hydrological services.* Long-term, local data is usually not available, and site-studies could be prohibitively expensive for small projects. Additionally, problems with deep leakage could result in water flowing underground from one basin to the other, rendering it impossible to establish upstream-downstream relationships with certainty.
- *Incomplete biophysical information.* A) The relation of forest-water is based on myths or popular perceptions: i.e. forests produce rainfall, forests increase dry-season flows. Some of these myths result in assuming benefits when they could in fact be costs. For example, large reforestation could result in significant reductions in runoff. B) There are studies that will point out the benefits of reforestation (i.e decreased sedimentation), but completely ignore the possible negative effects (i.e. reduced flows). C) Local hydrological studies using "black-box" approach that simplifies major land-water relations. Risk of "garbage in- garbage out" problem. D) Proper hydrological studies are expensive and need a lot of data. The solution seems to be to use this as an excuse and ignore them.
- *Incomplete markets.* There are no markets (or very few) where ecosystem services are traded. Even if they did exist, they tend to be immature, with few players and current prices tend not to represent the actual value of a service. In many places ecosystem services are used for subsistence production that does not reach the markets, making it more difficult to estimate quantities of production;
- *Shadow prices.* Government subsidies distort market prices and make it difficult to obtain a real value of the ecosystem service used in its production;
- *Extrapolation issues:* "Inflation" of the magnitude of local problems by using figures extrapolated from other sites. This is done in many cases in order to inflate project figures when local demand is low, or inexistent, to justify the initiative. It is not unusual for valuation studies to use figures from other places (i.e. contingent valuation results), and using big global figures always adds the sparkle that many people are after. The problem with this is that it can generate unreal expectations for local stakeholders.
- *Use of total flows - as opposed to marginal values:* A common problem in some cases is the confusion of "total flows" (gross effects) as opposed to "marginal flows" (net effects). Markets for watershed services look at the additional, marginal effects of alternative land uses on watershed services. For example a MWS should look at the additional units of water from improved water use, and not the total water flowing from a watershed. The basic premise here is that water flows would have come down *anyway*. It is necessary to look at how much more or less water comes down with or without project, or how much cleaner it is. For example, a study by Barrantes (2003), suggests that the hydrological importance

of forest is determined by the amount of water 'produced' in those areas. The author makes no attempt at considering the difference in water flows that alternative land uses would provide and the valuation results in overestimation of the true contribution of forests to water.

- There is a tendency to exaggerate possible effects of land use change (the typical "*deforestation will lead to desertification*" cry-wolf). The provision of watershed services might change after conversion of local land use, but very rarely it will stop altogether unless global weather patterns changed.
- *Figures do not reflect true values:* A) The opportunity cost many times does not include the best (or cheapest) alternative option. Many valuations do not include "with project" and "without project" scenarios. B) Assumption that water scarcity is a land use problem, when perhaps the best alternative would be water administration. The danger of this is that funds could be diverted to reforestation upstream, when they could be better used improving the pipe systems, reducing water waste, or improving water fees collection. C) Estimation of the environmental value of the service as the opportunity cost of land, instead of the value of the service as production input. This however is a contentious argument, as the final value of the service will result from a bargaining of the actual (or perceived) value of the service as input, but the ability to pay downstream, and the willingness to accept upstream.
- Another typical error is to ignore the possible costs of a land use change towards conservation. Conservation of forests might have positive values for biodiversity and downstream water users, but it will have direct on-site effects in terms of reduced access to local livelihoods (i.e. reduced collection of timber and non-timber forest products).
- *The timing of the flow of costs and benefits*. It is important to note the distribution of cost and benefits over the time horizon as well as differentiating between cumulative, punctual and sustained impacts. One should also consider that the impact of a land use could change over time; for example deforestation might increase runoff, but the magnitude of the effect will decrease over time as the new vegetation takes over. Timing is also very important when estimating opportunity costs, especially if they are seasonal-related.
- *Time scale, discount rates and inter-temporal valuation*. It remains an issue whether or not it is possible, or it makes sense, to measure the long-term value of a resource taking inter-generational aspects into account.
- *Ethical issues*. Most valuation methods (i.e. Cost Benefit analysis) are still based on an utilitarian and anthropocentric approach that does not include aesthetic or moral considerations (Echavarría, 2000).
- *Information gaps.* About the behaviour, role, and resilience of physical and ecological processes in watersheds. Ecological processes are very geographical and site-specific, and many times, despite having information available, decision makers fail to take it into account and follow prevailing myths about land use.

5.3.1 Where does the money for payments come from?

In theory, payments from water users downstream should be determined by the value of the environmental service in the production function. In reality, payment levels are being determined by regulation, government budgets, international cooperation, or through voluntary contributions from the private sector.

The most common sources of funding in markets for watershed services, discussed in Section 2.4, are:

a) Re-allocation of (national and local) government general budget. For example, the Mexico National PSAH, which relocates money from irrigation to forest conservation; both China national projects; part of the funding for the Plan Verde in Colombia; and the Working-for Water in South Africa.

b) New local sources, including:

b.1) Private investment (hydroelectric projects in CR, brewery), including contributions from parastatal groups.

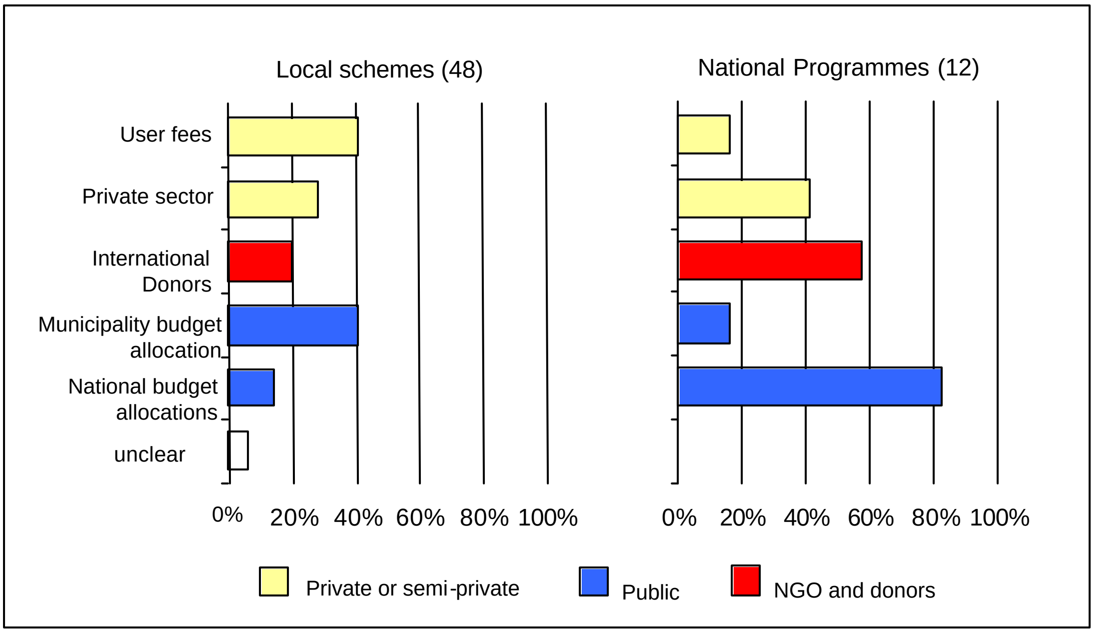
b.2) Additional user-fees (environmental fees in Heredia, CR, Juntas de agua in Central America), including user associations charges (Cauca Valle in Colombia)

b.3) Stricter regulation or collection of penalties for environmental services (existing or new).

c) External sources, in the form of international grants (GEF, GTZ, SDC, IFAD, etc) and loans (World Bank)

More than 60% of local schemes reviewed are receiving funds from the private sector. Fundraising from additional (environmental) user fees is used in 40% of the cases, and it has the advantage of being relatively easy to collect when water charges already exist, and being small enough to be acceptable by the end users. International sources are important sources of money, especially in national-level programmes where seven out of 12 of them are using grants and loans (especially in Central America) to set the programmes going (Figure 11).

Figure 11. Sources of funding in local schemes and national programmes



Unfortunately, the relative importance of the contributions from each sector is not shown in this figure, and not enough information was obtained to specifically compare their weight within projects. However, in most cases where information existed, the private contributions were relatively small compared to the other sources of funding such as donors or public resources. Nevertheless, these contributions provide an idea of the relative sustainability of the initiatives, as most external funding is seen as 'transitional' rather than open-ended (Hartmann and Petersen, 2004).

a) Re-allocation of (national or local) government budgets

Reallocation from central government is the main source of income in all the national programmes (except for the Philippines watershed fund and Ecoservicios in El Salvador, which theoretically rely on raising funds from the private sector). National level projects, like the PSA in Costa Rica or the PHSA in Mexico, have annual government budgets allocated for payments for environmental services. In Costa Rica the main source is the 3.5% of collections from a 15% tax on fuels. In Mexico it is approximately US$20-30 million per year.

Local municipalities have also taken an active role in these markets and can become a key player demanding watershed services in representation of the community. They are regular sources of money in 41% local schemes and 17% of national programmes. In many of these cases, funding comes from general annual budgets and it is the product of strong negotiation and leadership. In Brazil, for example, the municipalities in the watersheds of the rivers Piracicaba, Capivari and Jundiaí (PCJ) formed an Inter-Municipal Basin Committee to manage a watershed protection fund, formed by contributions from the company's profits and not an extra charge on water users. In other cases, the municipality raises funds through user-fees, transferring the cost to the final users.

National programmes often support existing local schemes. For example, the Coatepec Municipality in Veracruz launched a Water Trust (Fideicoagua) in 2002, and purchased 107 hectares of land in strategic riparian areas for conservation and study. Funds from the national PSAH have allowed them to launch a reforestation campaign of 6,500 ha in the cloud forest area. In Valle de Bravo, Mexico, a private NGO (Pro-Cuenca Valle de Bravo) began in 2000 to gather voluntary contributions to finance projects aiming at conservation of the forests and rivers of the region, and also access funds from the national PSAH. In most of these cases, however, the bulk of the funding comes from national budget allocation, raising doubts about their long-term sustainability once national funds stop.

b) New sources through private investment

The response from the private sector has been slow in terms of actual commitment of significant funds. There is however growing interest in demonstrating the 'business-case' behind investments in land-use improvements upstream, and it is hoped that this will result in higher levels of commitments. So far, the contributions from the private sector (including parastatal groups) come in the form of voluntary contributions or expected premium-based strategies, although it is expected that stricter regulation enforcement (from existing and new laws) can result in increased downstream funding.

Probably the most common way for companies to decide their payment levels is an internal, voluntary decision based on their own willingness to pay. Almost one third of local schemes receive funding from private and parastatal companies, and 40% of national programmes have entered agreements for co-funding with these groups. In most of these cases, funding comes from the company's profits rather than transferring the cost to the final consumers, and is usually registered as 'donation' (many tax-free) in their annual budgets.

In the Philippines, the Kanla-on Spring Water Plant (KSWP) draws spring water whose headwaters can be traced to the innermost strict protection zone of the park. Their business depends on the maintenance of the water quality in the watershed. The company fears that continual degradation of the forest is resulting in losses, and is investing in reforestation and local training. In all the hydroelectric projects in Costa Rica, funding for payments comes from the general company's budget, since prices of energy are externally determined and cannot be passed unto final consumers unless the (external).

There are also expectations that retail-based trading will increase downstream availability of funds by tapping into consumer's willingness to pay for environmental-friendly products. In the case of watersheds, payments for watershed protection are attached to existing consumer purchases. This mechanism usually requires certification and labelling from a trusted (independent) group to generate consumer recognition and encourage willingness to pay. A proposal for organic agriculture in Bhoj, India, depends on the possibilities of farmers entering niche organic that will either guarantee a higher price or at least a special market for their produce. There are no ongoing examples of watershed services in developing countries relying on retail-based trading for funding.

Although retail-based trading might not necessarily result in higher prices, it can be a strategy to expand market share. Even if this is not being explored in developing countries, it still represents a potential source of revenues that tap's into consumer's willingness to pay for a good cause (for example, a retail strategy from the brewery La Florida in Costa Rica promotion of "the environmental beer of Costa Rica").

Watershed services are frequently offered at a standard rate for different beneficiaries through user fees, thereby transferring the cost of environmental protection to the final user. This is a common system used by 40% of local schemes and 17% of national programmes.

User fees can be determined as a percent of the final water bill (for example, 20% of water in Pimampiro, Ecuador, or 5% in Cuenca, Quito), or a flat rate per cubic meter (1.90 colones/m3 in the ESPH in Heredia, Costa Rica). In Zapalinamé, Mexico, water users can select the payment level they want, with contributions varying from 1-1000 Mexican pesos per month. The majority of users (88%) pay less than 6 pesos/month. Once the amount is chosen, the extra fee appears in the monthly water bill.

Some user fees are introduced after consultation with local population to establish willingness to pay, but their final amount is more a reflection of the policies of the water utility and the costs of watershed protection. In some cases they are ultimately determined by an independent regulating authority (such as the case of the ESPH in Heredia, Costa Rica), or are the product of intense negotiation of local stakeholders reaching a "politically-acceptable" level (for example, the municipality of Jesus de Otoro in Honduras).

Additional water fees will tend to work in situations where water charges already exist. This is important in order to avoid situations where water charges are seen as politically inappropriate (for example, water is considered a right), and an environmental fee is perceives as a "first step towards water charges" (Robertson and Wunder, 2005). A clear example of this is in Tarija, Ecuador, where despite evidence of downstream willingness to pay for watershed conservation, the authorities refuse to accept the creation of the users charge.

Box 6. Introducing user fees in Pimampiro, Ecuador

Some markets for watershed services are based in externally imposed regulations and requirements. Although this is mostly the case in developed countries where environmental regulations are stricter, the interest is growing in developing countries. Market-based strategies are used to help companies reach environmental targets while reducing costs of compliance. In developing countries, regulation is mostly used to determine downstream contributions. For example, a new law in Costa Rica (*Canon del Agua*, approved in February 2006, but not yet applied) will enforce compulsory payments for all water users (including irrigation and hydroelectricity). Current payments levels for water are very low and they do not even reflect delivery costs. Approximately 20% of new funds collected will be transferred to FONAFIFO to be channelled as payments for environmental services in the watersheds where they are originated. Similarly, in The Philippines, hydroelectric companies pay a fee for watershed protection. These funds are not earmarked and therefore the link user-provider is weaker.

c) Grants and loans from international groups

There are many initiatives of payments for watershed services that are prompted and supported by international donors. This review has identified 20% of local schemes and 60% of national programmes using donor funding either for payments or to develop payment mechanisms. In theory, in many cases funding is only used to provide a kick-start in the project and support the very high setting-up transaction costs. In the practice, it is questionable whether many of these initiatives will manage to raise enough local funds to be self-sustainable in the long-run. **BACK THIS UP WITH EVIDENCE.**

Donor funding comes in different forms. For example, the Costa Rica's PSA has received several substantial grants from international donors. These funds, rather than being treated as 'donations', are perceived as investments for conservation of biodiversity and target particular areas of interests identified by the donor. In Pimampiro, an initial donation of US$15,000 from international donors helped set up a trust fund for their payments for environmental services, and this money is kept as a "stock". Money flows to make payments comes from water-fee collections from the municipality. The Los Negros project in Bolivia has covered all their initial transaction costs and payments (in the form of beehives) to farmers from international donors. It is only recently that the local municipality has begun contributing to the ongoing costs of the project.

Table 6. Environmental Service schemes with support from the World Bank, GEF and German cooperation

Country and region	International cooperation contribution (US$ millions) [1]	Description
Costa Rica (Ecomarkets)	World Bank: 32.6 GEF: 8	Effective 2001. Supports PES programme (German cooperation focusing on

Country and region	**International cooperation contribution (US$ millions)** [1]	**Description**
	KfW: 12.7	reforestation in northern region)
Silvopastoral Ecosystem Project	GEF: 4.5	Effective 2002. Piloting PES to promote adoption of silvopastoral practices
South Africa: Cape Action Plan for the Environment	GEF: 9	Effective 2004. Uses PES to conserve the Cape Floristic Region.
Mexico: PSAH	World Bank: 45 GEF: 15	(Approved in March 2006) Will strengthen and increase efficiency of the country's PES system and develop new financing sources
Kenya: Agricultural productivity and sustainable land management project	World Bank: 4.1 GEF: 4.5	Will pilot use of PES to reverse land degradation, and promote income-generating activities for rural farmers and to contribute to improved rural water quality. ICRAF provides technical assistance.
Costa Rica: mainstreaming market-based mechanisms for environmental services	World Bank: 30 GEF: 10	(Under preparation) Will ensure long-term sustainability of the PSA programme by developing new financing sources and improve the programme's efficiency
Venezuela: Canaima National Park Project	GEF: 11	(Under preparation). Will use payments from HEP producers to support conservation of Canaima national park.
Panama: Rural poverty and Natural Resource Management II	GEF: 6	(Under preparation) Will use PES to improve biodiversity conservation and generate water services
Honduras, Biosphere Reserve Rio Platano	KfW and GTZ[2]: 11.5	Shade-grown coffee, improved cattle pastures. Other agencies: Corporación Hondureña de Desarrollo Forestal.
Colombia / Rio Magdalena Watershed	KfW[2]: 28.1	Reforestation, protection of existing forests, sustainable forest management. Working with Federación Nacional de Cafeteros de Colombia.
Ecuador / Cordillera Chongón-Colonche	KfW[2]: 9.6	Reforestation, enrichment planting, shade-grown coffee and cocoa, improved pastures and communal forest control. Together with Fundación Natura.
Ecuador / Biosphere Reserve Gran Sumaco	GTZ, KfW[2]: 9.6	Shade-grown coffee and naranjilla, improved pasture, reforestation. Together with Ministry of Environment.
Peru / Jaén – San Ignacio Bagua	GTZ, KfW[2]: 6.4	Shade-grown coffee and cocoa, reforestation. Together with Instituto Nacional de Desarrollo, and a local project in San Ignacio.
Paraguay / Central and Eastern Region	KfW, GTZ[2]: 9.6	Soil conservation, reforestation, natural forest regeneration.
Dominican Republic / Alto Rio Yaque del Norte Watershed	KfW, GTZ[2]: 8.9	Reforestation, shade-grown coffee. Together with the Ministry of Agriculture and DED.

Notes: [1] World Bank financial assistance is in the form of loans and GEF and German cooperation through grants. [2]. Except for the Costa Rica project, none of the projects supported by German cooperation are explicitly called "PES", although they refer to payments to change land uses. In these cases the PES-type component is integrated into a broader conservation or forestry programme. Sources: World Bank, Environmental Economics and Indicators Website and Hartmann and Petersen (2004).

5.3.2 How are payment levels determined?

Markets for watershed services involve two types of payments: those *paid* by stakeholders interested in the watershed service (direct users, municipalities, government, international donors, etc), and those *received* by the service providers (private landowners, public lands, etc).

Although there are several attempts at assessing the value of the environmental service for the end user, most contributions are voluntary and come from several sources and not necessarily direct users (see Figure 11). Payment levels for upstream landowners should reflect, at least in theory, the economic value of the environmental service. In the practice this is very difficult to measure, and the best alternative is to estimate farmers' opportunity cost of economic activities forgone (Pagiola, *et al*, 2004). For example, payments in the Silvopastoril project are set at slightly more than this opportunity cost. The basic premise is that if payments are lower than the opportunity costs of land, farmers will have an underlying incentive to break the contracts and switch to other activities. Many schemes use this as an implicit or explicit guide to the payment levels (Pagiola, et al, 2004). At the same time, if payments are too high there is a risk of encouraging activities otherwise not profitable, where farmers will engage while payments exist but revert to previous activities once payments stop.

In Mexico, the government led programme has determined an annual payment of approximate US$30/ha for rainforests, and ~US$36/ha for cloud forests. These amounts have been determined by the government based on the opportunity cost of use of the land, assuming that earnings from corn production would be the alternative activity on the land. The higher payment on cloud forests reflects the perception on better and more water service from these types of forests. The opportunity costs vary across the country. In Sierra Gorda, for example, soil fertility is low and the payment more than pays for the opportunity cost of the reduction in grazing opportunities (Bayon, 2004).

The value of the compensation is not necessarily linked to the opportunity cost of the economic activity forgone. For example in Los Negros, Bolivia, the rewards in the form of beehives (per hectare) correspond only to 2-10% of the opportunity cost for setting aside land (Robertson and Wunder, 2005). Reported net-income per hectare in the project Jesus de Otoro, Honduras, are also much larger than actual payments (US$4-16), and claim that a 'fair' compensation should be approximately US$30/ha/yr. In both cases, the main reasons for joining the PES schemes were probably not only financial, but ways to secure land rights.

Some schemes decide their payments levels according to how much money they have and what is their target area. These projects experiment with an initial "*take it or leave it*" approach, and it is useful when funds are limited and opportunity costs of land or payment expectations are more or less known. For example, in Pimampiro, Ecuador, the municipality raises approximately US$500/month from user fees. The target area for protection is approximately 640 hectares of land (almost half is primary forest). Simple rules determined monthly payments levels of US$1.00/ha for undisturbed páramo or primary forest, US$0,75/ha for old secondary forest and 0,50/ha for new secondary forest.

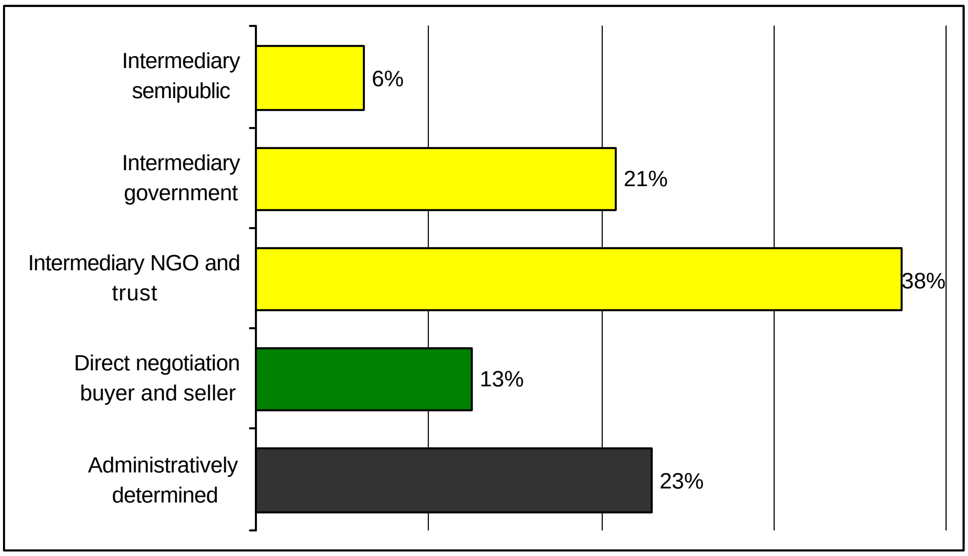
Sometimes expected payments are determined by the existence to previous subsidies (for forestry or agriculture), and this becomes a starting-off bias point for future payment levels. For example, payments for environmental services from reforestation projects in Costa Rica are a continuation of previous forest subsidies. The amounts were justified on high expectations from future carbon markets (unmet until today), but in reality it was unlikely that anyone would engage for less than the previous subsidy. Also, determining by Law a payment of approximately US$50/ha/year for conservation has led to other projects using this as their initial reference point.

In general, it is possible to identify two basic types of mechanisms used for price discovery:

a) Administratively determined (non-negotiable) payments.
b) Negotiable deals through direct negotiation between sellers and buyers, negotiations through intermediary and trading systems (including auctions).

It is not unusual for schemes to have a combination of price discovery mechanisms. For example, in the case of the national PSA programme in Costa Rica, although payment levels to providers are administratively set for the national programmes, payments from water users are the product of important negotiations with the intermediary. Many of these national-level intermediaries work alongside local facilitators, who help to bridge the final gap with local farmers and water users.

Figure 12. Mechanisms for price discovery in local schemes



a) Administratively determined (non-negotiable) payments

An authority, usually the government, can determine payment levels. In these cases, bargaining power by farmers or water users is limited. In the case of farmers, they can voice their willingness to accept by choosing not to join. This potentially can send signals back to the authority to adjust their payment levels. This type of payments is mostly used in national-level strategies.

There are 21% of local schemes where the payments, especially those to farmers, are administratively determined by an external authority, leaving little room for negotiation. For example, in Pimampiro, Ecuador, the municipality and the local NGO designing the project determined payment levels. The formula was simple: available monthly funds collected from user fees divided by the total area they wanted to target. Payments were slightly adjusted by the degree of degradation. For example, primary forests and páramos get $1 per hectare, while intervened landscapes receive less than that (Echavarría *et al*, 2003). Valuation studies done several years after the project was implemented provide more formal support for the use of those values (Ordóñez and Puglla, 2004).

All payment levels in national programmes are administratively determined. The only exception is in the pilot project Ecoservicios in El Salvador, where the government negotiates with local stakeholders. In most cases, the government decides payment levels. For example, all payments to farmers in Costa Rica are determined by FONAFIFO, although the contributions from downstream users are the product of negotiation with particular users.

b) Negotiable deals

'Simple' mechanisms like direct negotiations actually involve detailed contracts outlining land management practices in exchange of agreed amounts of money (cash or in-kind). There are relatively few cases of direct negotiation in local schemes (13%). They are mostly used in situations when there are few stakeholders involved and/or are capable watershed programme already exists, and presumes a certain degree of negotiation between sellers and buyers.

INCLUDE one box with example from either of these: Cauca Valley, Makiling, La Esperanza, Lake Toba, Bhodi-Suan Nala, San Pedro Norte (PASOLAC).

The majority of ongoing local schemes rely on negotiations through intermediaries (65%) for price discovery. NGOs and trusts are the most common category (38%), followed by government (21%) and a mix of private and -public entities (6%). As explained before, this category assumes some degree of negotiation between buyers and sellers when reaching consensus over prices. In Los Negros, Bolivia, important negotiations were conducted through the NGO Natura with farmers and downstream users to establish the "exchange rate" of beehives for forest, finally agreeing on 10 hectares of primary forest, but also allowing for different amounts for intervened forests. MAYBE ANOTHER EXAMPLE HERE?

Most sophisticated methods for determining payment levels include auctions. More popular in developed countries such as USA or Australia where controls are stricter, they have not been used so far in developing countries. An auction system will ask farmers to bid for payments depending on their own opportunity cost, and will result in differentiated payment levels across the target area. The next section discusses auctions in more detail.

5.3.3 Mechanisms for transferring and managing funds

Once payment levels are agreed, it is important to establish the best way to manage and transfer funds among stakeholders. These mechanisms vary according to their degree of complexity. Simpler mechanisms are direct payments from buyer to seller and internal trading. Trust funds are increasingly used and quite popular in Latin America.

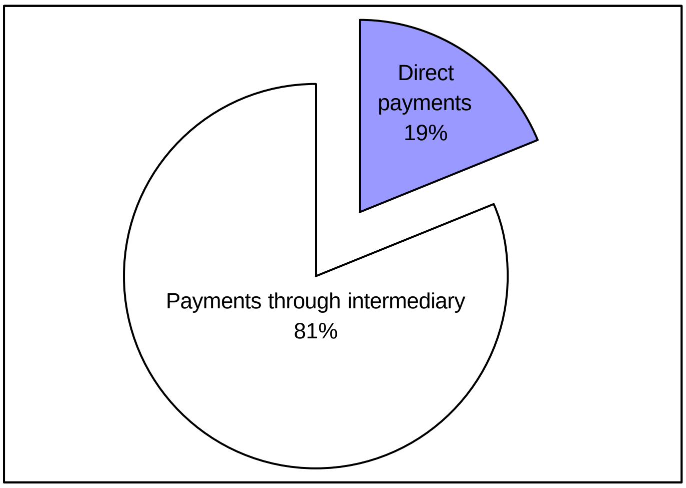
Mechanisms for transferring funds include:

a) Direct payments from buyer to seller

b) Payments through intermediaries (including trust funds)

c) Trading systems: "Over-the-counter", clearing-house, retail-based trading, trading platforms and auctions

Figure 13. Transferring funds from buyers to sellers



a) Direct payments from buyer to seller

Service users can make direct payments to the providers. Usually the product of direct negotiations, direct payments take place when there is few participants, especially one main downstream user. In these cases, the user has the financial and technical capacity to administer payments. For example, the ESPH in Costa Rica, a private water utility, collects payments from end-users through an additional environmental charge in their water bills. Before they embarked in payments for environmental services, the company already had an environmental department in charge of monitoring and linking up with local communities. When the programme was established, it only required the creation of a separate fund to allocate earmarked revenues. Payments are subsequently transferred from the fund directly to the farmers either through a bank account.

b) Payments through intermediaries (including trust funds)

An intermediary is good for collecting payments from water users in pooled transactions, when the existing water user does not have the financial ability to manage the payments, or they simply do not have the inclination of engaging in the activity. For example, the CNFL in Costa Rica has several hydroelectricity projects. They rely on the national intermediary FONAFIFO to allocate payments to farmers and manage the programme for them rather than engaging in activities that are not the objective of the company.

Trust funds are mechanisms used to receive and manage funds for a broad thematic purpose as opposed to a specific project. Trust Funds are separate accounting entities, with a designated trust fund manager, or Executive Coordinator. A trust fund can be used when payments come from different types of sources at different scales of time (for example, annual lump-sums, monthly payments from users, or one-off grants from donors), and for making payments to a range of watershed activities. It is also helpful to pool together funds for different types of environmental services (for example, water and biodiversity conservation). A Trust Fund provides long-term financing; and provides a useful transparent platform for public, private and international participation interested in environmental services. However, they require substantial up-front investment. In most on-going trust funds, this initial sum of capital comes from an international donor, although in the case of Quito, Ecuador, the Fund was established by users payments and left to capitalise for several years and the revenues generated by interests are used to fund watershed conservation activities.

The fact that a Trust Fund is a legal unit, with separate status and bank accounts and potentially long-term viability, can be useful to improve trust among stakeholders. On the other hand, it is important to highlight that while highly attractive, establishing a trust fund could entail long and complicated legal issues, and the intermediary must either have the capacity to coordinate this effort, or should be able to hire the required experts to do so. Wunder and Alban (2005) warn that keeping funds in a Savings Account rather than a Trust Fund with legal restrictions could potentially be a threat for the long-term viability of the schemes (Pimampiro, Ecuador).

Several small payments for environmental services pilot schemes taking place in Honduras, El Salvador and Nicaragua, and coordinated under the PASOLAC regional programme, are creating Environmental Funds as their main intermediation mechanism (Fund for Environmental Services). Seed funding is provided by SDC (through their local offices CONDESAN) for capacity building, initial studies and negotiations among stakeholders. The Fund is supported by the creation of a Municipal Law (*ordenanza municipal*) made to specify changes to tariffs, additional fees, or fund allocation to the bank account. This Law establishes how the fund will grow, managed, how contracts are drawn and with whom, as well as administration of monitoring and sanctions. Downstream users, mostly municipalities or water boards, contribute to the Fund through additional water fees, or direct lump-sums of money into the bank account. Although PASOLAC is currently supporting approximately 12 of these initiatives, most of them are at a very early stage (Perez, 2004).

c) Trading mechanisms

Trading mechanisms include over-the-counter (OTC), clearing-house, retail-based trading, trading platforms and auctions. In **OTC transactions** the service is "pre-packaged" as a commodity for sale (water quality credits, park entrance fees and carbon offsets). In developed countries, watershed services are frequently offered at a standard rate for different beneficiaries through user fees. This rate is normally not negotiable and imposed on all beneficiaries.

While most watershed service agreements will support cooperation among stakeholders as ways of reaching negotiation and ensuring minimum threshold, other mechanisms seek to introduce competition, for example, when funding is limited. This spectrum of mechanisms includes internal trading (taking place within an organisation or different government sectors); clearing-house transactions (offering a central platform for buyers and sellers to exchange a pre-packed commodity), and auctions (which move a step closer to a competitive market by allowing buyers and sellers to bid for the environmental service).

These systems take place mostly in developed countries. They are still largely immature, and require an existing respected authority to establish initial regulations and discharge targets (caps). For example, watershed-based trading emerged in the USA with the publication of a draft framework in 1996 (EPA, 1996). The framework builds on the Clean Water Act (1972), which determines the maximum pollutant loading capacity consistent with federal water quality standards which are then allocated within states between point and non-point source discharges (Landell-Mills and Porras, 2002). Trading schemes are designed to help states meet these targets in a cost-effective manner by allowing opportunities for offsetting point source pollution with non-point source reductions, such as agricultural best management practices. Another example is the Environmental Service Investment Fund in New South Wales, Australia, which manages salinity credit trading through a clearing-house. The Fund supplies credits to buyers, and purchases credits from landowners. An auction format seeks to channel payments to the most-effective salinity reduction measures. Auctions require landowners to compete in terms of the number of credits they would offer for a given price. The Fund also provides an accreditation service to minimize risk for buyers (Landell-Mills and Porras, 2002).

Although the use of cap-and-trade has been rather limited in watershed services, there are many examples of this type of market mechanisms used for natural products such as fisheries (MacGregor, Karousakis and Groom, 2004) and auctions for wildlife products (see Box 7).

Box 7. Auctions for wildlife products

The main points from trading approaches are:

- For market-based trading approaches to work, there must be a history and acceptance of regulation prior to engaging in participative or voluntary approaches (Shelton, 2005).
- Heterogeneity: trading schemes must reflect differences in outcomes, management options, cost structures, goals, financial and farming structures, and preferences to realize gains from trade;
- A significant number of participants need to allow for price-discovery and prevent collusion;
- Overcoming opportunity costs issues. One of the main problems of establishing the price to pay for environmental service is the lack of information about opportunity costs. Opportunity costs vary in location, time, and the personal circumstances. Centrally-designed programmes, such as the PSA in Costa Rica, cannot take into account these variations and by using one single figure they might be overpaying farmers who would engage at a lower price, or they might not be creating enough incentive for farmers in strategically located areas. With an auction-based system, the government or authority sets a target, and landowners make decisions based on their own (real or perceived) opportunity cost when choosing their bidding levels;
- Asymmetric information. One of the main problems with auctions and trading schemes is asymmetric information. Farmers need to understand the trading game in order to maximise their potential gains, and they need to understand the land use activities necessary to deliver the service at the best price. This is a clear restriction in most developing countries. In the Wimmera case in Australia (Shelton, 2005), the auction system is unlikely to focus or benefit any disadvantage groups. The use of a flat rate is easier to administer and probably more fair in cases of asymmetric information. At the same time, when information is limited, it would be difficult to justify in a politically convincing way the existence of different payment levels.
- Bundling. Shelton (2005) suggests that in terms of project design, it is best to keep the ecosystem goals simple, as multiple goals will tend to require multiple actions

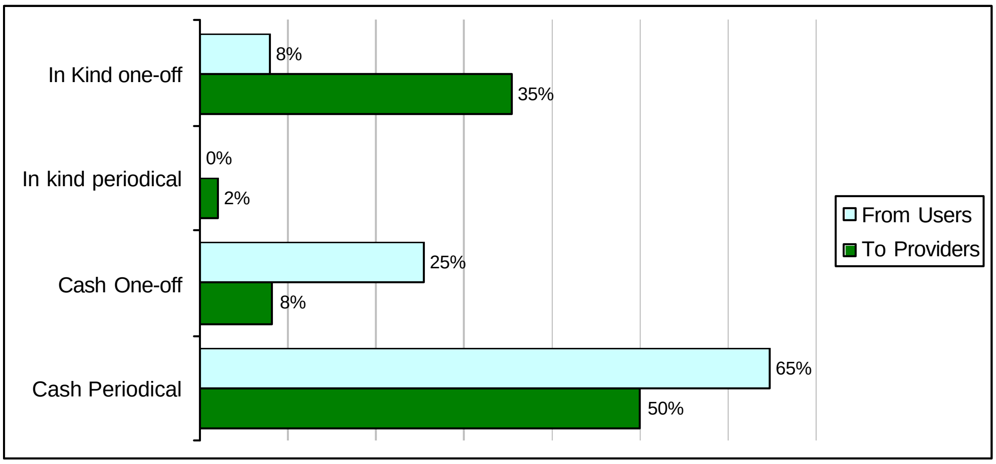
and this would complicate the system. The problem with this approach is that in many cases one service will not be sufficient to generate enough demand to pay for upstream investment.

- Trust. For the system to work there need to be a trustable authority behind the scheme, that provides the platform for exchange, channels payments from the service users to the different providers, monitors and administers sanctions in the long-term.
- Land tenure needs to be clear from the start, as well as tenure over the environmental service.

5.3.4 Unit and timing of payments

Payments can differ in unit (cash or in-kind) and timing (periodical or one-off) (see Figure 14). Almost 60% of ongoing local schemes make **cash payments**, most of them periodical[3]. The majority of periodical cash payments take place in Central America, and one case in Ecuador (Pimampiro). One-off cash payments were reported in only two cases in India (Kuhan catchment and Bhodi-Suan Nala), one in Indonesia (Brantas) and in the Maasin, Philippines. In the Maasin case organised communities were paid for the labour costs involved in reforestation. They were also given stewardship of land for 25 years (potentially renewable for another 25 years).

Figure 14. Types and timing of local schemes



Cash payments have several advantages. They provide an immediate, recognisable signal to the receiver, and the effect of non-compliance is easily understood and felt by the receiver ("*no service, no payment*"). A cash payment has the advantage of being easier to administer, and their potential economic gains are high by feeding directly into the family budget. The level of payment depends on the particular context. Ideally, payments should be determined by the real value of the environmental service. However, in most cases, payments are initially determined by how much funding is available, or by the

[3] In theory 'periodical' refers to 'open-ended', ongoing payments. Although in the practice payments are established for the life of a contract, they are considered periodical if these contracts can be renewed if all parties are willing and able to do so.

opportunity cost of land, and then this figure is set up for negotiation with upstream stakeholders (see previous section).

Table 7. Examples of payment levels for watershed services (US$/ha/yr)

Costa Rica		Ecuador	
La Esperanza HEP		Pimampiro	
During construction	$3	Primary Paramo and Forest	$12
Year 1 of operations	$8	Intervened Paramo and forest	$6
Year 2 of operations	$9	Secondary Old Forest	$9
Year 3 and 4 of operations	$10	Secondary Young Forest	$6
Year 5 and onwards based on formula 1			
Energia Global HEP	$10		
CNFL	$40		
Platanar HEP			
If property titles2	$15		
If no property titles	$30		
Agreement CCR and ESPH			
Cerveceria CCR	$45		
Heredia Water Utility (ESPH)	$22		

1. $10*(Gr/Gf)*(Tavg/Tbeg), where Gr: real energy generated during the time period, Gf is the forecasted energy production for the time period, Tavg is the average power tariff (US$) paid through the time period, and Tbeg is the tariff (US$) paid for the energy generated on the first day of the time period.

Table 7 presents some indication of payment levels in Costa Rica and Ecuador. Notice that in the Costa Rica case, the amount represents the money paid by the water user, not the final amount received by the landowner, who receives an average of $40/ha for conservation. This amount includes payments for all the other environmental services. It is also important to note that while the payment levels for the Pimampiro initiative are significantly lower, the actual payment levels represent approximately 20% of the household budget for the families involved (Echavarría *et.al,* 2003). The structure of the payment is key. For activities like conservation, an even payment through time is fine. But activities like reforestation for salinity control will require large up-front investments and payments tend to reflect this situation. Monitoring from a trusted organisation, and the applications of sanctions, is key for investors as ways to minimise risk from their investments in these land use activities. In Australia, for example, the response effects are expected to be visible in 10-30 years.

Sometimes cash payments might not be enough to engage upstream landholders. For example, participation of private landowners in the PSA in Monteverde, Costa Rica, is rather limited. A study in the area (Porras and Hope, 2005) indicates a rather inelastic response to payment levels fuelled, among other things, by suspiciousness of the government motives (see **Error! Reference source not found.**). In situations like this, **in-kind transactions** might be a good alternative.

In-kind transactions are being used 35% of ongoing schemes, and are primarily located in Bolivia, Ecuador, Indonesia, India and China.

Only in one case in-kind payments are periodical. The Los Negros scheme in Bolivia gives one artificial bee box (and apiculture training) per year to each Santa Rosa landowner who agrees to set aside 10 hectares of primary forest for conservation. Contracts are renewable on an annual basis. In most of the cases, payments are one-off and in the form of support for watershed conservation projects upstream. Some examples of in-kind payments are:

- Bolivia (Tarija). Farmers living within the Sama Reserve are able to participate in conservation activities, like reforestation and fire control. About 25 communities live inside the reserve, with a total population of 4000 inhabitants.
- Brazil (CPCJ). Farmers living along riverbanks in targeted areas receive a reforestation plan (including approval of the relevant environmental authorities and technical assistance) and (native) tree seedlings; plantation and maintenance are responsibility of the landowner; there are no further incentives given after this initial phase;
- China (Meijiang): Orchard investors are able to lease land from small landowners through a village committee. The investors make significant profits in establishing the orchards, and they have obligations to conserve the hilly land and prevent soil erosion as a requirement to access the lease. The government can provide one-off subsidies to help with the soil and water conservation practices.
- Colombia (Funeque). The transition costs to organic agriculture incurred by small farmers are paid through loans from commercial banks. The 'PES-type' incentive to farmers is in the form of a Fund, which serves as guaranty (for 10% of the debt) for the loans.
- Ecuador. Payments to upstream farmers are made in the form of loans and technical advice to farmers on the middle part of the watershed to help them increase their water use efficiency (Cuenca), community projects (Ambato), and financial support for watershed conservation projects (FONAG).
- Guatemala (Sierra de las Minas). Best management practices and conservation projects with farmers in buffer areas of the Sierra de las Minas National Park are financed through training and capacity building. The project aims at providing cash payments at some stage if enough funding is raised.
- Honduras (Campamento). Technical assistance to farmers for improved agriculture methods (especially coffee), as well as community projects and installation of latrines to deal with human waste.
- India (Sukhomajri). Upstream villages refrain from allowing their animals to graze on the watershed hills (in order to maintain vegetation cover for soil protection). As compensation, villages receive access other pasture areas, construction of rain water collection dams that improved water supply to the village and attribution of water use rights to all households within the village.
- Indonesia (Sumberjaya, see also Box 8). Best management practices through community agroforesty in exchange for land tenure for 25 years, with a trial period of 5 years; plus multipurpose tree seedlings provided by the Forestry Service. RUPES is also testing an additional direct financial payment and/or in-kind payment from management of hydropower company and domestic water users
- Pakistan (Mangla Dam): Farmers living above the Mangle Dam receive technical assistance and other inputs for the construction of soil and water conservation structures upstream from the dam reservoirs. Farmers contribute the equivalent to 30% of labour costs.
- Philippines (Mt Kanla-on). Agroforestry activities with farmers living within Mr Kanla-on Park aiming at stabilization of riverbanks and soil conservation measures to arrest soil erosion in the recharge area for a spring water plant. In-

kind payments made through tree-saplings, two nurseries and reforestation with 100,000 fruit and timber trees. Farmers also receive technical assistance to adopt sustainable agroforestry practices such as SALT (multi-storey, rock walling and use of organic fertilizers).

Situations in which in-kind transactions (as opposed to cash payments) might be useful include:

- There is strong opposition to the term "market", and cash is directly associated with it;
- Cash payments could be culturally unacceptable;
- There is fear that direct cash payments could cause frictions within the upstream communities;
- Upstream groups might be more interested in other benefits, such as improved roads;
- Cash is not the traditional exchange unit in the upstream communities;
- It is perceived that the land use improvements could be better achieved by targeting skills and efficiency rather than by making payments;

Box 8. Social Forestry in Indonesia – Kerr…

5.3.5 Summary and conclusions

Following a purely economic principle, environmental service programmes should try to maximise the amount of environmental benefits per dollar spent by carefully selecting payment levels to farmers. Paying for the value of the environmental services is a fairer but rather non-practical option, given the limited available information. In the practice, most schemes pay a flat rate per type of land use based on the opportunity cost of land (the PSA for conservation in Costa Rica pays the opportunity cost of renting out the land), or a proportion of the costs of engaging in a new land use activity (such as reforestation). Newer schemes are trying to introduce different levels of service provision in the price-determination (for example, the Silvopastoril project or Ecoservicios in El Salvador). Until now, no major efforts other than theoretical have been made to move to a more efficient method that includes risk of land changes or differentiated opportunity costs for farmers.

A key challenge for markets for watershed services is the identification of critical areas. This potentially means differentiated payments that reflect a) the risk of loss of watershed services; b) the geographical location of the provider (i.e. riparian areas are more sensitive for sediment discharge); c) the opportunity cost involved in switching activities. This will require the move from the "first-come, first-served" approach to a more science-based approach. Hydrological maps can be overlapped with risk-prone areas, and socio-economic studies can group farmers according to their location, willingness to engage, and required compensation levels (see Hope, *et al*, forthcoming).

When it comes to determination of payment levels, ongoing experience suggests that payments are not economically determined by the (theoretically) combination of supply and demand. Instead, they are the results of negotiations. Kosoy *et al*, (2005) call these prices "tips, supports, or social recognitions" of the adoption of good practices by upstream landholders, who are anyway more or less socially (and morally) obliged to do so.

Making payments for environmental services tend to work either when the value of environmental service is high and the cost of provision is low (for example, there are limited threats to the critical areas upstream, which results in lower opportunity costs of land). However, according to the UNISFERA report (CITATION HERE), payments can also work when both value and cost is high, as long as the payment exceeds the cost of provision. In the practice this is more difficult for watershed services, where downstream contributions remain fairly modest and face potential problems when dealing with higher value activities that raise the opportunity cost of land, such as urbanisation (for example, the ESPH in Costa Rica).

Payments should in theory be open-ended and linked to a continuous provision of environmental services, subject to compliance (UNISFERA report). Half of the cases reviewed make cash, on-going payments to farmers, mostly in the case of conservation of existing ecosystems that do not produce alternative income to the landowner (i.e. PSA for conservation in Costa Rica and Mexico, and payments for protection of altiplano forests in Pimampiro, Ecuador). Payments can also be seen as transitional incentives to switch to improved land management practices that will result in better and sustained future incomes. This option is preferred by donor agencies, such as the German Cooperation (Hartmann and Petersen, 2004). Pagiola *et al* (2004), suggest making payments slightly higher than the opportunity cost of land, and lower than the total cost of investments in land practices. In this way, the farmer has an added incentive to keep up the investment in the longer term.

Most payments are allocated through intermediaries (80%). Direct trading mechanisms like over-the-counter transactions, clearing house and auctions are more sophisticated methods to allow price discovery in a more competitive way. Landell-Mills and Porras (2002) reported the use of these mechanisms in emerging schemes, almost all of them located in developed countries. These mechanisms are not being used in developing countries at the moment. The only exception is the Certificates for Environmental Services (CSA[4]) in Costa Rica, sold as an over-the-counter (OTC) commodity.

[4] This new mechanism is the Environmental Services Certificate (CSA, in *Spanish*). Each certificate has a $300 face value and is valid for five years. It guarantees the protection of one hectare of forest located in important water catchment areas (including forest fires prevention). FONA FIFO (2005), website.

5.4 Legislation

- ‘Stream-flow reduction’ in South Africa is a commodity easy to understand in a context of water scarcity. An added advantage is the strong scientific evidence backing the linkages between land use and water. However, legislation has not managed to accommodate the proposal and it is still not clear whether additional water rights can be sold or bought. **Maybe move this to mechanism.**

6 Impacts of the initiatives

(Address different types of impact: environmental, social, economic by looking at costs and benefits (financial and non-financial) for different groups)

valuation studies. Some of the schemes reported valuation studies to understand willingness to pay and accept. Given the limitations in data collection for this review, it is impossible to say with certainty in how many of the cases this valuation studies contributed to the determination of the final payments.

FONAFIFO has transaction costs of 7% of its annual budget. Intermediaries, such as FUNDECOR or CODEFORSA, charge between 12-18% of the payment to cover all their expenses (including technical support). The ESPH has managed to keep transaction costs down by incorporating the environmental service unit into their regular work. The key rule here is to build on existing capacities, and avoid unnecessary expenses (such as office supplies, cars, etc).

6.1 Social and economic costs and benefits

Maryanne.

6.2 Environmental costs and benefits

Ina

7 Conclusions, lessons and recommendations

Key lessons are drawn on:

- The negotiation process: understanding providers, and demand.
- Lessons on facilitators
- Insights on the overall legislative and institutional framework
- Trade-offs
- Science and perceptions

7.1 The negotiation process

7.1.1 Understanding the providers

1. *Developing a social baseline*

A clear description and basic understanding of the social baseline in the impact area will help develop the site-specific approaches that will result in higher participation and impacts (Maasin, Philippines). It is important to remember that social disparities in the groups involved can make the definition of uniform criteria a difficult task (Ambato, Ecuador). Stratified control groups, as the ones used in the Silvopastoral project, are useful to understand what changes can be attributed to the project.

2. *Size and institutional capacity matter*

It is easier to engage with few farmers (ICO, Bolivia), especially if they are well organised and more open to watershed conservation measures (Maasin and Makiling, Philippines). Pilot projects with small areas are useful to generate trust and as a learning process. However, small pilot projects will not likely manage to achieve threshold levels required to make a significant impact on watershed services (Jesus de Otoro, Honduras). However, specific punctual projects with successful results can become catalysts for regional development (Fidecoagua, Mexico; PASOLAC in Central America contributing to the shaping of national programmes in Honduras and Nicaragua.

3. *Make the objectives of the project clear and easy to understand*

It is important to clearly state the objectives of the deal, as they can be undermined by confusion regarding land regulation, privatisation or fear of expropriation for conservation (Los Negros, Bolivia; Cuencas Andinas, Sierra de las Minas in Guatemala). Cultural sensitivities about terms such as ‘payments’ or ‘markets’ need to be dealt from the beginning, avoiding changes mid-way. For example, changing the term from payment to ‘*improved management of hydrological resources*’ resulted in additional confusion, underscoring trust, and weakening the link between land management and environmental services (Los Negros, Bolivia). The weakening of this link can have negative impacts in ensuring participation. Farmers’ perceptions of payments ‘for poverty reduction’ can tacitly result in lowering the importance of commitments to better land practices (Maasin, Philippines).

4. *Incentives to engage in better practices need to be clear, tangible, and cover opportunity costs*

Payments for environmental services represent a clearer incentive for better land practices (Hartmann and Petersen, 2004). These incentives need to be clear, and able to cover at least opportunity costs. Small pilot projects with limited funds may have a low impact on the income of providers, highlighting issues of fairness (Jesus de Otoro, Honduras), threatening with non-compliance once the scheme is up and running (Pimampiro, Ecuador), and overall creating a limited incentive to adhere to contracts in the medium and long term.

When payments cover the opportunity cost of land they result in reduced potential for conflict and increase participation (ICO, Bolivia; Sierra Gorda, Mexico). Critical recharge areas with high opportunity cost (such as urbanisation in the ESPH, Costa Rica) may need stricter regulation, such as zoning, accompanying payments for environmental services. In areas where natural resources are already degraded, payment levels have to compensate for potential losses in income from reduced-impact activities, as well as the cost of making improvements (Ecoservicios, El Salvador). However, in the practice the values for compensations are set arbitrarily, and not responding to economic valuation and demand analysis (Mayrand and Paquin, 2004).

A direct payment to the farmer provides quick benefits, instead of indirect impacts through the production function as a result of best management practices (Hartmann and Petersen, 2004). However, projects that promote this type of practices should pursue a benefit for the farmer beyond the payment for environmental service (i.e. Meijiang, China). Adaptation of the reforestation industry to fast-growing species (such as *melina*), and finding markets for small-diameter timber from forest thinning helps generate important income for small farmers (Costa Rica). Relative simple systems that produce recognisable, direct benefits can become catalysts for change in the longer term (Arvari, India). Investments in training and capacity building for farmers are useful to increase participation (Jesus de Otoro, Honduras).

Farmers can feel forced to participate in better practices through social pressure (especially in intra-community arrangements, such as ICO, Bolivia), or when there is a hidden risk of expropriation (Jesus de Otoro, Honduras). In both types of situations voluntarism is compromised, and the deals can be easily broken.

5. *Engaging with poor groups*

How watershed deals impacts poorer groups depends on several issues. In order to maximise the delivery of the service, projects need to target those areas that are more likely to have an effect. In some cases these areas are located closer to population centres, and are not necessarily inhabited by the poorer groups, who tend to be located in remote areas. Even if farmers live in these areas, they are usually scattered, and have significantly less access to information and capacity to administer a PES project. Their participation will be restricted, unless the project trades-off higher transaction costs to subsidise inclusion.

Payments for environmental services have limited effect where there is extreme poverty and lack of basic infrastructure (Fidecoagua, Mexico). But payments are also presented as a potentially good tool for working with communities in sustainable forest and watershed conservation projects, helping them out of extreme poverty through direct cash inflows and improvement in social conditions to promote motivation (Fidecoagua, Mexico; *Ecological Compensations in* China; conservation payments in Osa, Costa Rica; Cauca Valley, Colombia).

It is difficult for small farmers to benefit. Small, less educated farmers tend to be excluded in national programmes, such as the PSA in Costa Rica (Zbinden and Lee, 2004). They might face additional limitations in the decisions over their land, such as mortgages or debts with informal lenders, even if they have property titles. Legal requirements, complex and expensive bureaucratic procedures reduce participation from small holders (PSA, Costa Rica). Conservation activities also require farmers to have 'spare' land to set aside. Reforestation activities demand a high level of initial investment beyond the level of the incentives, and the investment periods are long. Agro-forestry systems integrated in management of environmental services are a viable option for many small farmers (Rosa et al, 2003), as they provide short-term benefits in the form of crops and payments for environmental services, and long-term on-site benefits such as improved soil quality and timber.

6. *Gender issues*

Women are key decision-makers in the household, and are more willing to enter projects that will improve the chances of their children. They are however traditionally excluded from land ownership or capacity building processes, usually led by male facilitators (Fidecoagua, Mexico). Their participation in deals tends to be restricted, because culturally land ownership remains in the hands of the husband. In very local schemes, such as Pimampiro, Ecuador, an informal 'social monitoring' can take place making sure that the payment is assigned to the person living and managing the property, regardless of the title. Using this system project managers ensure that funds are allocated to the family household even in the case of divorce or separation.

7. Political and civil unrest creates added instability

It is difficult for farmers to engage in long-term initiatives in situations of civil unrest, although it is possible that they can co-exist, as it is the case of Colombia (Cauca Valley and Plan Verde). The schemes have survived through armed conflict, because it provided rural employment, involved local authorities, although it is possible that some of this money was extorted from communities (Cardenas and Rodriguez, DATE?).

7.1.2 Understanding the business of the users

1. Institutional capacity of users

Weak downstream organisation can slow down negotiations (i.e. irrigation groups in Los Negros, Bolivia, Ambato, Ecuador). The creation of user-associations is valuable investment in social capital and can be used for cooperation in other areas (Cauca Valley, Colombia).

In general, deals for watershed services are more likely to evolve faster when water charges already exist, as there is deep aversion to paying for water that is currently considered free, especially among irrigation groups (Los Negros, Bolivia).

Payments from end-users should be easily enforced and collected. One of the main reasons for success in the ESPH, Costa Rica, is that the scheme is easily enforced and monitored. End-users are well identified and metered, payments can be tracked on monthly basis; non-compliance of payments can be tackled through suspension of the service. In this way the company can identify a steady flow of funds (Luis Gámez, personal communication). Bad collection of funds is one of the main limitations of the Pimampiro scheme in Ecuador.

2. *Water utilities play a very important role as representatives of end-users*

Water utilities tend to be managed by local governments (municipalities), or as private (usually non-for-profit) enterprises. Publicly managed utilities depend on changing political will, which can easily change with different administrations threatening the long-term sustainability of the initiatives (Pimampiro, Ecuador).

In most cases, water utilities are able to create and collect additional charges for environmental services. Using additional funds from users, local municipalities are able to invest in protection of water sources, when traditionally they had to limit their role to treating water (Sierra de las Minas, Guatemala). The creation of these charges will be easier for water utilities already providing a good water service, with acceptable quality and distribution system (ESPH, Costa Rica). The participation of end-users can be active (Fideicomiso, Mexico), or restricted by limited consultation (El Imposible, El Salvador).

3. *Conflict resolution can be a strong motivation to participation*

Conflicts over water quantity can be particularly acute in dry areas, with extended dry season periods where local needs may clash with tourism places demanding larger amounts of water (hotels, swimming pools, golf courses, etc). Tourism companies might use ‘payments’ for watershed services as a way of dealing with ‘fairness’ towards water allocation (Conchal, CR), or to access water resources (such as building pipes in La Esperanza, Costa Rica).

Strong issues regarding declining water quality have been successfully dealt through payments for watershed services in Jesus de Otoro, Honduras, with downstream water users sitting down to discuss incentives with coffee producers upstream. The case of Arvari, India, illustrates that deals can be achieved in communal areas with high levels of mistrust and degradation, but the process is long. All decisions are made by the community, are strictly enforced and each person in the collective community is individually responsible to carry out the outlined tasks. Communities have to bear at least 25% of the costs of infrastructure.

Payments accompanying a command-and-control measure can reinforce each other, by increase resource use downstream and investing part of the avoided costs in non-point pollution upstream (Sierra de las Minas, Guatemala).

4. *Commitments from downstream users are slow in coming and limited in amount*

In most local schemes, present level of funding from direct downstream users is insufficient to ensure that required threshold levels are met (CPCJ, Brazil; Jesus de Otoro, Honduras; PASOLAC experiences in Central America; Zapalinamé, Mexico). The main reasons for these include:

- Lack of 'endorsement' from larger water user groups (i.e. large hydroelectric groups) restricts the potential for capturing sufficient funds (Fidecoagua, Mexico; Pimampiro, Ecuador). In Costa Rica this has been overcome through the creation of a new "Canon del Agua" which taxes all water users.
- Downstream users can take a "wait-and-see" attitude when an active facilitator exists, expecting them to obtain funds from somewhere else and solve the situation (Robertson and Wunder (2005) on Los Negros, Bolivia).
- Economic instability can result in reduction of membership in user groups and lower funds for investment (Cauca Valley, Colombia).
- Lack of 'paying culture' and free-riding makes it difficult to strike deals (Pimampiro, Ecuador; Mexico).
- Water users do not want to pay additional fees because the current water service is inefficient (Campamento, Honduras).
- Even if water charges exist, bad collection systems could result in lower than expected funds collected (Pimampiro, Ecuador);
- Political conflict over management and sharing potential benefits from collection of fees can delay or stop negotiations (Makiling, Philippines; introduction of the Canon del Agua in Costa Rica – pers.comm. with Alexandra Saenz, FONAFIFO).

5. *Lack of information about impacts on production function reduces participation*

In some cases, lack of environmental awareness can slow down deals (CPCJ, Brazil), or make the company see deals as public relations rather than company's investment in risk mitigation (Sierra de las Minas, Guatemala). The first step in the FONAG-Ecuador scheme was to target the main water users for awareness through a short publication about the importance of the project, and how it would work.

Lack of adequate accounting of the contribution of watershed services in the GDP restricts the "business-case" potential of PES-type schemes (CR-PSA). Limited information sharing on the part of downstream industry for water valuation studies (Sierra de las Minas, Guatemala).

7.1.3 Determining payment levels and strategies

Final payment levels are the product of intense negotiations, usually through a facilitator (see Section 5.2.3). Payment levels are usually influenced by availability of funds or the opportunity cost of land, and tend to be a flat rate offered for all participants (Mexico, Costa Rica, Pimampiro).

Auction systems are good to reveal opportunity costs of participating in the schemes. However, this mechanisms is commonly perceived 'too innovative' for developing countries because of uncertainty, risk aversion, administrative costs, lack of information, etc. It is also perceived that it will result in further exclusion of small farmers with higher opportunity costs (PSAH Mexico, PSA Costa Rica). Clashes with the introduction of polluters-pay principle can be avoided by using 'credits' against own investment in soil and water conservation measures (proposed in Makiling, Philippines; *Canon del agua*, Costa Rica).

Making small increases in downstream charges have the advantage of being less opposed to, helping to establish the reputation of the scheme but limiting the collection of funds necessary to achieve threshold levels upstream (Jesus de Otoro, Honduras; Zapaliname, Mexico).

The use of a rotating credit fund (instead of direct payments) ensures that smaller amounts of money go further, reduces the implementation costs of activities; and reduces the expectation of 'free subsidies' from farmers (Cuenca, Ecuador; Myrada, India;).

Payments from downstream users linked to tax breaks and ability to choose allocation of funds could lead to abuse of the system. For example, in Certificates for Conservation have been bought by a private hotel chain (Reserva Conchal) and 'invested' in their own private reserve.

Using trust funds is useful to ensure long-term sustainability, but they can take many years to mature and provide enough revolving funds to support payments upstream (FONAG, Quito).

Trying to maximise the sources of funding is a useful strategy to ensure money flows that are sufficient and sustainable in time (Mayrand and Paquin, 2004). The main draw back of this approach is that it may result in general actions, rather than specific and targeted to those areas that are more likely to deliver watershed services. FONAFIFO has tried to keep different options for funding, with the view of ensuring a continuous, secure flow of funding. While still relying heavily on the fuel tax, they steadily look for other funding options such as carbon sales, agreements with private water users, environmental service certificates, loans, debt-swaps, donations, etc. The ESPH charges an extra water fee in their water bill, easy to tract and collect. Local intermediaries try to do several activities, such as consultancies, to ensure their costs are met, and do not rely completely on funds from PSA.

7.2 Facilitating the negotiations

7.2.1 Forming strategic alliances

1. *Trust at the base of negotiations*

Trust is the hard-won result of a long process, and a key factor in fostering watershed deals. Downstream users need to trust that particular land uses will result in improved watershed services, and that upstream farmers will stick to their 'end of the deal' (ICO and Los Negros, Bolivia, in Robertson and Wunder, 2005). In Los Negros, Bolivia, the facilitating NGO Natura used donor funding for setting up the system and for the first round of the payments – downstream users are now contributing to payments upstream. "*Using short-term donor funds, the farmers are thus demonstrating to downstream users—the potential long-term funders—that upstream watershed protection is feasible* *and trustworthy—as long as appropriate incentives are provided*." Vargas, M. T. (2005)

2. *Creation of strategic alliances is key for the development of the schemes*

Early alliances with key stakeholders (at community, municipal or provincial levels) are key for the outcome of negotiations, influences the type of information disseminated to the public (Ambato and Pedro Moncayo, Ecuador; PSAH and Valle de Bravo, Mexico; PASOLAC schemes in Central America;) lays down the foundations for implementing a solution (Makiling and Maasin, Philippines) and provides crucial support in terms of resources, the fluidity of the process and access to international funding. Conversely, lack of political support can easily undermine a project (Makiling, Philippines) even if there is willingness to pay for watershed services, especially in the context of creation of water charges (Tarija, Bolivia).

The creation of **multi-stakeholder committees** involving users and providers encourages the feeling of ownership and provides a platform for discussing water uses (Cuenca, Ecuador; PASOLAC in Central America).

It is worth remembering that open and participatory discussions of PES proposals increases stakeholder engagement, but increases initial cost of the project (Ambato, Ecuador) and can delay negotiations (Mt Kanlaon, Philippines).

3. *The Government can be a large player*

Government funding can be substantial for national programmes. However, these programmes are shaped by the political agenda that does not necessarily reflect local needs. For example, lobbying groups (i.e. conservation groups in Costa Rica) can determine policy priorities, rather than having them shaped to respond to actual local needs. Government funding tends to be unsteady and prone to change with different administrations. For example the PSA in CR has changed several times, and pledged amounts have not been always delivered.

An objective of government-led programmes in Mexico and Costa Rica is to facilitate the creation of local deals. On the other hand, experience in Meijiang, China, suggest that strong national approaches led by the Government can des-encourage local engagement.

Mostly because of bureaucracy and the absence of appropriate channels for feedback, lessons from the NGO sector take time to seep into the Government sponsored schemes, and the shortage of resources results in programmes administrated by existing government staff without the capacity or skills to promote innovation (Myrada, India).

The timing and pacing of funds from the Government is not necessarily the most efficient to make the best use of matching resources:

- Implementation of schemes that require voluntary work have to be planned for the months of the year when people have more time (i.e. off-harvest times). This has a negative impact in promoting people's participation (Myrada, India).
- Funding from the Government usually needs to be spent following annual budget procedures. This can lead to rush decisions in allocation of resources (PSAH Mexico)

Decentralized management of water resources is useful to capture local resources for local needs, and engage local stakeholders in solutions for their problems (CPCJ, Brazil, Cuenca and Pimampiro, Ecuador; NIPAS Law in the Philippines);

4. Donor funding is very important

Using donor funding to kick-start the project is useful and very necessary to cover the high level of implementation costs and background studies. Almost all ongoing projects and advanced proposals depend on donor funding for the initial costs (Mayrand and Paquin, 2004). However, in most cases donors see their participation as transitory (Hartmann and Petersen, 2004) and sustainability of initiatives is on stake if downstream payments are not enough to continue after donor funding stops (Los Negros, Bolivia).

Funding from international donors is very important, but it needs to be treated with care. Funds coming from different sources can result in contradicting objectives and "investment overkill", reducing the need to engage with local sources of funding (Maasin, Philippines).

5. Long-term investment in environmental awareness

Moving towards a more integrated and holistic approach to watershed management requires a cultural evolution of people's preferences towards forest protection. This is a continuous, long-term process linking the education sector, private companies with high corporate responsibility standards, economic opportunities such as ecotourism, etc. In Costa Rica the process has been slow, with significant drawbacks and mistakes, but changes are taking place and in barely 20 years the country as a whole has managed to reverse one of the fastest deforestation trends in Latin America.

7.2.2 A clear scientific background helps to build the business case

1. Science and perceptions

Having the scientific base (even in rough figures) in place can help make the link stronger (Maasin, Philippines). However, in most ongoing schemes, access to climatologic data is difficult (Cuencas Andinas, Sierra de las Minas, Guatemala).

Lack of physical evidence has not stopped hydroelectric companies in Costa Rica from signing the extension of initial contracts for five additional years. Although some of these companies consider that the main reasons for paying for environmental services is public relations, they still think that a positive effect on avoided further sedimentation is taking place.

When science does not provide the answer, perceptions take their place. In most cases reviewed, there are strong perceived (rarely measured) linkages between land degradation (especially deforestation) and decline of water resources:

- Perceived links between land use and water quality or quantity help negotiate local deals (ICO, Bolivia; PSAH Mexico; Maasin, Philippines);
- Sierra de las Minas, Guatemala *"once money flows upstream, enough water will flow downstream – WWF, 2004*);

- Downstream groups believe that large forest cover will lead to better water quality and greater water availability. Most users think that water provision is the most important benefit from forests (Jesus de Otoro, Honduras)
- Uncertainty about effects of conservation on water quantity is switching the emphasis towards water quality for hydroelectric plants, encouraging the development of integrated watershed management in agroforestry systems through organic agriculture, etc. (agro*conservation* in PSA in Costa Rica, Silvopastoral project, Ecoservicios El Salvador);
- Uncertainty over negative trade-offs from reforestation (i.e. potentially less sediments, but also less water) can stop downstream users buying in (Singkarak, Indonesia);

2. Background studies and information flows

The importance of background studies to understand both users and providers is increasing, especially at the request of large donor-funded projects such as the World Bank and the GEF. Although their practical application continues limited, in some places not reflected in final payments and considered only 'lip-service' (Jesus de Otoro, Honduras), it is important to remember that most payments are the product of intense negotiation, and background studies provide the initial ranges of acceptable values.

Background studies are conducted by specialists in the different areas (economists, hydrologist, sociologists, etc) usually contracted out. These studies may help policy makers understanding the case for higher fees, especially where these are controlled by external regulating institutions (like ARESEP in Costa Rica).

Project implementation can be limited by capacity to use existing technology, such as GIS systems, or understanding of the participation guidelines (Fidecoagua, Mexico; Mt. Kanla-on and Watershed Rehabilitation Fund, Philippines). This can be tackled through the creation of guidelines, toolkits and programmes establishing procedures, and workshops and networks involving practitioners and policy makers to share cumulative experiences (Mexico PSHA, RUPES).

NGOs can play important role in raising awareness with communities, for example through the creation of information centres where voluntary activities are carried out, such as data generation, and conflict resolution (Maasin, Philippines).

3. Matching commodities and watershed services

In many cases watershed services and commodities are poorly matched. The definition of the service remains vague, sometimes on purpose as project managers try to "cast their nets wide open", for example, from biodiversity or carbon sources. As a result, the land use practices promoted not always represent the most efficient way for providing the watershed services required by downstream users.

Even if PES is promoted as a useful mechanism to target priority areas and limit objective (Hartmann and Petersen, 2004), this is not a common practice in ongoing projects, especially those at national level. The emphasis on protecting existing forests in some projects takes away resources that could be more effectively used in restoring degraded areas, which tend to be the source of most environmental problems (Sierra and Russman, in press).

7.2.3 Management of schemes

1. *From national approach to local needs*

The applicability of national schemes at local level can be limited by funds and local capacity.

Lack of able local facilitators negatively affects national programmes, as they are unable to respond to local needs (PSA in Costa Rica). The lack of national funds to support market creation leaves most issues related to monitoring, evaluation, and long-term sustainability hanging or being 'shouldered' by the participants themselves (Mexico PSAH).

2. *Institutional capacity*

Management system should be based on existing capabilities, and kept simple and transparent. The basis for the Costa Rica PSA programme is a 'no rocket-science' approach (Johnny Mendez, pers.comm., Feb 2006). FONAFIFO has kept the concept of environmental services wide and this has facilitated their ability to adjust as the context changes. Bundling services maximises funding possibilities. The "judgement of Solomon" applied when dividing the payment into four equal parts for each service (carbon sequestration, landscape beauty, biodiversity conservation and watershed protection) was not fair, but it allowed the system to begin working. Contracts should be kept flexible, as much as possible. Open-ended, continuous payments reduce transaction costs and increase sustainability and programme credibility (Mayrand and Paquin, 2004). Flexibility allows for adjustments to improve efficiency and adapt to changing conditions. A reported drawback is the loss of institutional credibility resulting from changing the rules of the game, and that farmers living in remote areas will not have access to the information required to understand the changes (PSA Costa Rica).

The institution selected for managing the scheme has to be credible, and have a clear long-term strategy for the management of the scheme. The opposite can undermine deals if not in place (Tarija, Bolivia, Ambato, Ecuador). Personal intermediation by a (independent) promoter or PES can play an important role in motivating and informing landowners, leading to increased participation (for example, Fundecor and Codeforsa in CR).

Transparency is key in building up trust in the participants. The inclusion of as many groups as possible from the beginning will provide future support for the initiative. But it is important to remember that an over democratic and complicated system might also hinder the project. It is important to draw the line, making sure to include flexibility in the operation of the schemes. Flexibility can be introduced continuously through annual decrees. However, this is a double-edge sword, as it helps to incorporate lessons from previous years (such as setting up critical areas), but it can also confuse the rules of the game.

Downstream users might prefer deals through facilitators to avoid entering in activities not related to their business. For the CNFL in Costa Rica, hydroelectricity remains their main business and all administration of contracts with farmers is delegated to the national intermediary FONAFIFO. Partnerships between NGOs and local water utilities can be successful, but NGOs should try to seek for local, more permanent institutions to manage the scheme in the long-term. In Pimampiro the NGO CEDERENA helped the local municipality build the scheme several years ago, and their recent departure from the area seems to go as a smooth transition. However, it is still uncertain where the Municipality will be able to obtain the additional resources needed to manage the scheme.

3. *Learning process and feedback channels*

One-to-one negotiations are lengthy and expensive, however, they help create institutional capacity and learning from what individual business want before embarking in over-the-counter deals (i.e. La Florida, CR).

Learning by doing is an important source of experience, and it is important that the facilitator builds the appropriate channels to ensure feedback. A ‘seasoned’ facilitator is key to bring trust. Good reputation from deals triggers the emergence of other deals elsewhere. FONAFIFO in Costa Rica has achieved experience in managing funds, dealing with farmers and businesses through a few local schemes (such as Energía Global and Platanar). This helps demonstrate their capacity to respond at local level with the new (significant) funding available through the new water charges (*canon del agua*).

Institutions that can develop payment mechanisms are those with (Perez, 2005?):

- a legal structure in place (personería juridica);
- autonomous work schedule;
- decision-making power;
- already manage funds from those (indirectly) demanding water (i.e. populations);
- mechanisms to ensure local participation;
- transparency in management of funds;
- technical capacity to implement PES.

7.3 The overall institutional framework

Markets for watershed services should not be built from scratch, and should incorporate long-term lessons from the existing systems. This includes previous legislation (good and bad), technical lessons from failed projects, and learning from soil and water conservation projects.

7.3.1 Legislative framework

Existing legislative and institutional framework can affect the formation of environmental service schemes mainly in several ways:

1. Fostering deals with the creation of an institutional and legal framework through specific national laws (i.e. Environmental Services Law in Costa Rica and Mexico) or Municipal Laws (PASOLAC in Central America). An important lesson from ongoing experiences is that, through negotiations, Payment systems can help the creation of institutional and legal frameworks in places where did not exist (San Pedro Norte, Nicaragua). It can also reinforce the process in places where it already exist (PASOLAC, Central America).

2. Delaying or stopping negotiations where the legal basis for making additional charges is unclear (Makiling, Philippines).
3. Slowing down negotiations in places with inadequate water management norms and policies (Sierra de las Minas, Guatemala).
4. Sending conflicting messages by supporting the type of economic activities that the Payments schemes are trying to change. For example, the largest and most inefficient water users (agriculture, ranching) usually do not pay for water, have no extraction limits (Mexico, Ecuador), or have extensive subsidies (for example, the electricity industry in Mexico, agricultural and ranching sector in Zapalinamé in Mexico and Fuquene, Colombia).
5. Over-emphasis on forest conservation only can leave out (and send negative signals) to agricultural groups already involved in sustainable use of resources (Mexico, PSAH)
6. In some places, history of inefficient subsidies (especially to the forestry sector) may limit policy-makers and general public' trust in the introduction of payments (Mexico).

7.3.2 Property rights over land

A key advantage of payments for environmental services is that landowners retain their property rights. Because they are intrinsically linked to land, farmers must have the ability to make and hold decisions on its use for a significant period of time. Disputes over land ownership can easily stop deals (i.e. replication of ICO's in Mairana, Bolivia), or make payments to farmers difficult and expensive to track (Tarija, Bolivia). Land tenure instability can come from armed conflicts (like in Colombia), and from conflicting land allocation government projects, like land allocation for landless peasants in Costa Rica and for former guerrillas and army members in Jaltepeque-Jiquilisco, El Salvador.

Resistance to the introduction of watershed payments can come from colonist groups, who may object to giving up land for 'conservation' (Robertson and Wunder, 2005). Cattle ranching groups have strong economic and political influence and are highly profit oriented (Fuquene, Colombia).

The design of watershed deals need to take into account the degree of restriction they want to impose on landowners, as it will affect the likelihood to engage in the scheme. Landowners may not want to enter deals that restrict their land use options in areas where the value of land is high. New systems have to evolve to take this into account in areas where it is key prevent major environmental water problems (like in the ESPH, Costa Rica).

7.3.3 Property rights over watershed services

Centre to the discussion of property rights is the notion of who owns the water, and even more difficult, the watershed services.

In most places, water is recognized as a valuable input, but considered open access resource (such as Sierra de las Minas, Guatemala), undervalued, underpaid or free. Overall, the assumption is that water is a public good administered by the Government on behalf of all. While in most cases landowners do not own the water that comes out of their properties, they are implicitly considered 'protectors' of the watershed services.

In most developing countries, formal 'markets' to sell 'additional units' of watershed services do not exist and agreements are based on perceived impacts of land activities, rather than punctual measuring. But the lack of certainty over service rights can slow down deals. For example, in South Africa, downstream users are not allowed to buy additional water credits beyond their initial allocation, therefore limiting the potential for land-based activities upstream to 'liberate' and trade water resources.

Allocation of water rights de-linked from land rights ensures that landless poor can capitalise over their share of water, for example by selling it to larger landowners. This creates a direct incentive to participate in watershed management activities, solves the problem of inequity in benefit sharing, and compensates for loss of access to traditional grazing lands (Sukhomajri, India)

7.4 Dealing with trade-offs

7.4.1 Targeting the payments increases efficiency and effectiveness

The biggest challenge for markets for watershed services is in identifying and targeting critical areas. This potentially means differentiated payments that reflect a) the risk of loss of watershed services; b) the geographical location of the provider (i.e. riparian areas are more sensitive for sediment discharge); c) the opportunity cost involved in switching activities. This will require the move from the "first-come, first-served" approach to a more science-based approach. Hydrological maps can be overlapped with risk-prone areas, and socio-economic studies can group farmers according to their location, willingness to engage, and required compensation levels (see Hope, *et al*, forthcoming).

Targeting the areas that will deliver the most hydrological benefits is expected to increase the efficacy of the payment (Robertson and Wunder, 2005 about Los Negros, and the new approach of the Institute of Electricity in Costa Rica). For example, forest in the upper parts of high mountains is in less risk of changing or over-use than middle parts of the watershed. Payments can be designed to target those areas in particular (Vogel, 2002 on Pimampiro, Ecuador).

Lack of systematic spatial targeting results in under funding (S Wunder (2005); Pagiola 2002, lack of additionality, and potentially loss of higher environmental benefits if other areas could be integrated in the scheme (PSAH, Mexico). Explicit grading system can be incorporated in evaluation of proposals, to help identify areas more valuable for environmental benefits, and where true modification of conduct would be achieved by the economic instrument (i.e deforestation risk analysis) – PSAH, Mexico.

"the number of forest owners who apply for enrolment of areas in the scheme far exceeds the availability of funds. This is probably due to a combination of under funding of the scheme and its lack of systematic spatial targeting. In many cases, those receiving PES funds may not have had genuine intentions in the first place of putting the land to an alternative use, thus implying limited additionality of the system, i.e. the PES systems buys less extra environmental protection than would have been possible with increased targeting." Roberston and Wunder (2005).

7.4.2 Inclusive, pro-poor schemes raise transaction costs

Timeframe for bureaucratic processes can be long and can deter small farmers from entering (Cuencas Andinas; CR-PSA; Myrada, India; Mt.Kanla-on, Philippines;)

Process of engaging and fund-raising can be slow and 'painstaking' (FONAG, Ecuador.

7.4.3 Conflicts over final objectives of the schemes

1. *Water service required from end-users may be linked to distribution*

End-users may feel entitled to improved water services as a result of increased water charges. In most cases these improvements are more related to infrastructure, water distribution, treatment, cleaner production (Pimampiro, Ecuador, Sierra de las Minas, Guatemala;; Mexico PSAH); or more directed to conservation of biodiversity (Sierra de las Minas, Guatemala; Los Negros, Bolivia), than land-related watershed services. In most cases, payments are most efficient when they take place parallel to improvements in water infrastructure projects that ensure proper delivery of water to final users (Pimampiro, Ecuador).

2. *Conservation agenda may not respond to downstream needs*

Conservation groups pushing their own agenda 'forcing' the water link of forest-water can create conflicts of interests with downstream users (for example, circulation of incorrect information about the role of paramos in Ambato, Ecuador). Over-stressing doubtful relationships (i.e. forests and increased water quantity) may obstruct possibilities of concentrating on more positive spin-offs from watershed-based deals (PSA in CR).

Payments for forest protection could potentially result in better water quality and biodiversity conservation. However, downstream users are generally more interested in water quantity, which relates directly to water management and not so much forest conservation (Los Negros, Bolivia).

3. *Overstressing the poverty agenda has costs*

Where possible payments should target small farmers to have a social objective. However, the actual objective should be the actual delivery of environmental services (PASOLAC, Central America). Dealing with larger properties reduces transaction costs and help achieve threshold levels more easily, and it is possible that pressure to convert to other uses is less. (Zbinden and Lee, 2004). However, smaller properties have higher risk of conversion and inappropriate land management, and should be especially targeted.

An important limitation to projects is the political agenda of local municipalities (especially in poorer areas), which tends to be more focused to solving short-term, tangible projects (such as health or water supply), weakening the link between investment and environmental service (Watershed Rehabilitation Fund, Philippines).

8 Annexes

8.1 Case Profile

Summary			
Maturity of the initiative		Proposal or ongoing scheme Active since when? Status with respect to silver bullet.	
Driver		Unclear, government regulation, supply side, demand side	
Stakeholders	Supply	Categories: public gov.land public communal land private landowers private reserves local ngos and trusts	Small involved? (information on the size of properties involved)
	Demand	National level government local government (municipality) corporate business (hep…) user associations national/local ngos and trusts international ngo research groups, universities	About the intermediary… also its funding/ affiliation? (ie. Independent donor, percentage charged over the payment, etc) , is it a participant or a stakeholder?
	Intermediary		
	Facilitator		
Market design	Service	Water flow regulation, water quality maintenance, erosion and sedimentation control, land salinisation reduction/water table regulation, maintenance of aquatic habitats.	
	Commodity	Best-Management Practices: Reforestation for commercial plantations Conservation and protection of existing ecosystems Rehabilitation of degraded ecosystems for protection	
	Payment mechanism	Direct negotiation intermediery based transactions (trust, government agency, ngo) pooled transaction over-the-counter clearing house transaction auctions internal trading retail-based market (environmental service) user fees	What are the eligibility criteria/requirements for participating in the scheme eg formal land title, minimum size of landholding is it voluntary or compulsory? How do they avoid free-riding? What exit strategy can buyers use if they wish to stop buying the es? (from wunder and robertson) ???? Are its incentives aligned for a successful system, better environment, happy people, low transactions costs, pr, etc?
	Type of payment	- in kind (describe which eg. Training; support to access loans, markets; behives) - cash one-off - cash instalments (describe period and conditions)	
	Funds involved		

<table>
<tr>
<td rowspan="5">Analysis</td>
<td rowspan="4">Costs and benefits</td>
<td>Economic</td>
<td>Includes the costs of institution building (e.g. Transaction costs). This should be a focus of this new review. How much (roughly) are they? It might be worth to try to obtain indicator (number of people involved, since when did the proposal begin, etc). Who is paying for setting up costs? For how long? Who will pay for them after? Is the initiative likely to be self-sustainable?</td>
<td rowspan="4">- Are costs and benefits verified and perceived/expected
- try to relate the costs and benefits to the different stakeholder groups</td>
</tr>
<tr>
<td>Environmental</td>
<td>Describe the physical characteristics of the upstream area and why is it important to protect (this is already on the demand point of view); environmental impacts other than on the environmental service being considered, proportion of the whole watershed under the scheme? Scientific evidence? Has each case made studies? Have trade-offs been considered? What types of land use activities were taking place there before the system? Have these activities stopped or are they taking place somewhere else? (leakages) (see also monitoring)</td>
</tr>
<tr>
<td rowspan="2">Social</td>
<td>Describe the socio-economic characteristics of the upstream area – main land uses, livelihood strategies, stakeholder groups, size and distribution of landholdings, income groupings, etc; impact of the payments onto the family's income (we have to estimate this from standard minimum wage, for example</td>
</tr>
<tr>
<td>Impacts on vulnerable groups: impacts for current welfare flows (economic, social, environmental)
impacts on assets (physical, financial, human, social, environmental capitals)
impacts on security (e.g. Property rights)
, livelihood, financial, etc)
impacts for empowerment</td>
</tr>
<tr>
<td colspan="2">Legislation issues</td>
<td colspan="2">Legislation issues: preconditions for market establishment (and operation), e.g. Legislation, institutional capacity, mechanisms for ensuring local participation, the development of partnerships, government support, educational programmes, finance, etc. Legislation issues. Country-wide regulations? Local initiative? Existing laws for water and land use? Overlapping and contradicting laws. How is the initiative dealing with this? There might not be much information about this, but it will provide useful insights for on-going initiatives that have to deal with water being controlled by many authorities.</td>
</tr>
</table>

	Monitoring	Monitoring (contingency issues) what has been the degree of/ likelihood of compliance so far, and what factors have influenced it? What's the mechanism for monitoring and performance assessment? Are the payments directly contingent on ES provision (e.g. On water quality) or rather on the land use that is supposed to produce the ES (e.g. On conservation of native vegetation)? Time/frequency of monitoring. Monitor: external or internal? Certification schemes? Establishment of baseline. Biophysical monitoring? Leakages? How are different fluctuations and risks which ES providers traditionally have little/ no control over being dealt with (e.g. Drought, fire, external intruders' actions)?
	Main constrains (problems)	**Main obstacles** faced in market establishment and how these have been overcome. Obstacles to market development can be **split between demand side** (e.g. Low willingness to pay, lack of information) and **supply-side factors** (e.g. Insecure property rights, lack of finance, political risk, inadequate legal framework).
	Main policy lessons	Is sustainable joint production with other forest goods and services possible? Impacts for current welfare flows (economic, social, environmental) impacts on assets (physical, financial, human, social, environmental capitals) impacts on security (e.g. Property rights) livelihood, financial, etc) impacts for empowerment
Additional information		· additional references to chase up · problems with reference · gaps in information
Contact		
References		
Links		

8.2 List of cases reviewed

Country	Name	Current Status	Status during Silver Bullet
Africa		**(14 cases reviewed)**	**(5 cases reviewed)**
Kenya	Western Kenya Integrated Ecosystem Project	Ongoing	
Malawi	Electricity company watershed protection contracts	Uncertain	Pilot
Malawi	Water boards -protected area contracts	Uncertain	Proposal
Malawi	Water boards -watershed protection contracts	Uncertain	Pilot
South Africa	Working for water	Ongoing	
South Africa	Working for wetlands	Ongoing	
South Africa	Maluti Drakensburgh	Ongoing	
South Africa	Sabie-Sand catchment	Advanced proposal	
South Africa	Selati River	Advanced proposal	
South Africa	Stream-flow reduction licences (PES component)	Abandoned or discontinued	Pilot
Tanzania	South Nguru Mountains (WWF/CARE/IIED)	Advanced proposal	
Tanzania	Uluguru Mountains (WWF/CARE/IIED)	Advanced proposal	
Uganda	Brewery and wetlands in Lake Victoria	Borderline	
Zimbabwe	Integrated catchment management in dryland areas	Abandoned or discontinued	Proposal
Asia		**(38 cases reviewed)**	**(15 cases reviewed)**
China	Forest Ecological Compensations programme;	Ongoing	
China	Guangdong Province,	Uncertain	Pilot
China	Jiangxi Province	Uncertain	Pilot
China	Meijiang;	Ongoing	
China	Shiangxi Province,	Uncertain	Pilot
China	Hebei Province,	Uncertain	Pilot
China	Northwest	Uncertain	Pilot
China	Sloping lands conversion programme;	Ongoing	
India	Bhodi	Ongoing	
India	Kuhan	Ongoing	
India	Sukhomajri	Ongoing	Mature
India	Arvari	Borderline	Mature
India	Bhoj wetlands	Advanced proposal	
India	HM (Inter-state watershed protection contracts)	Uncertain	Proposal
India	Myrada	Borderline	Pilot
Indonesia	Lake Toba	Ongoing	
Indonesia	Bandung (GEF/LP3ES)	Potentially ongoing but no info	
Indonesia	Brantas	Ongoing	
Indonesia	Cidanao	Ongoing	
Indonesia	Halimun (WWF/RUPES)	Advanced proposal	
Indonesia	Nunukan district, East Kalimantan (WWF/CARE/IIED)	Advanced proposal	
Indonesia	Sinkarak Lake (RUPES)	Advanced proposal	
Indonesia	Sumberjaya (with RUPES);	Ongoing	Pilot
Indonesia	Ujung Kuon (WWF/CARE/IIED)	Advanced proposal	

Country	Name	Current Status	Status during Silver Bullet
Indonesia	West Lombok (Nusa Tenggara Barat)	Advanced proposal	Proposal
Korea	Green Belt Project	Advanced proposal	
Nepal	Kulekhani	Advanced proposal	
Pakistan	Mangla-Dam	Ongoing	Pilot
Philippines	Bakun (RUPES)	Advanced proposal	
Philippines	Kalahan (RUPES)	Advanced proposal	
Philippines	Maasin	Ongoing	
Philippines	Maikiling	Advanced proposal	Proposal
Philippines	Mount Isarog (WWF/CARE/IIED)	Advanced proposal	
Philippines	Mt Kanla-on	Ongoing	
Philippines	North Sierra Madre (WWF/RUPES)	Advanced proposal	
Philippines	Sibuyan island (RUPES/WWF/CARE/IIED)	Advanced proposal	
Philippines	Watershed Rehabilitation Fund	Ongoing	Proposal
Vietnam	Government watershed management contracts	Uncertain	Pilot
Central America and the Caribbean		**(42 cases reviewed)**	**(13 cases reviewed)**
Costa Rica	CNFL	Ongoing	
Costa Rica	Del Oro	Abandoned or discontinued	Proposal
Costa Rica	Energia Global	Ongoing	Proposal
Costa Rica	ESPH	Ongoing	Proposal
Costa Rica	ICE	Ongoing	
Costa Rica	ICE-Arenal Watershed Fund	Abandoned or discontinued	Pilot
Costa Rica	La Esperanza	Ongoing	Pilot
Costa Rica	La Florida	Ongoing	
Costa Rica	Platanar	Ongoing	Pilot
Costa Rica	PSA –including CSA	Ongoing	Pilot
Costa Rica	San Jose Watershed Fund	Abandoned or discontinued	Pilot
Costa Rica	Silvopastoral	Ongoing	
Dominican Republic	Procaryn	Advanced proposal	
El Salvador	Jaltepeque-Jiquilisco	Ongoing	
El Salvador	Coatepeque	Ongoing	
El Salvador	Ecoservicios (national programme)	Ongoing	
El Salvador	El Imposible	Ongoing	Pilot
El Salvador	Pasolac led #1 (place?)		
El Salvador	Pasolac led #3 (place?)	Ongoing	
El Salvador	Pasolad led # 2 (place?)		
Guatemala	Cerro San Gil	Ongoing	
Guatemala	Cooperative agreements in Sierra de las Minas	Advanced proposal	Proposal
Guatemala	MAGA National	Ongoing	
Guatemala	San Jerónimo (GTZ)	Ongoing	
Honduras	Campamento	Ongoing	
Honduras	El Escondido	Advanced proposal	
Honduras	Jesus de Otoro	Ongoing	
Honduras	Orica Creek (WWF/CARE/IIED)	Advanced proposal	
Honduras	Rio Platano (GTZ)	Advanced proposal	
Jamaica	Buff Bay	Advanced proposal	
Jamaica	Watershed protection contracts and fees	Uncertain	Proposal
Mexico	Copalita	Potentially ongoing but no info	

Country	Name	Current Status	Status during Silver Bullet
Mexico	Fideicoagua	Ongoing	
Mexico	National PSAH	Ongoing	
Mexico	Pronatura	Potentially ongoing but no info	
Mexico	Valle de Bravo	Ongoing	
Mexico	Zapaliname	Ongoing	
Nicaragua	San Pedro Norte	Ongoing	
Nicaragua	Silvopastoril	Ongoing	
Panama	Chagres (Panama Watershed Canal)	Abandoned or discontinued	Proposal
Panama	Filo del tallo	Uncertain	Proposal
St Lucia	Talvern Watershed	Advanced proposal	
South America			
Bolivia	Bermejo (international with Argentina)	Abandoned or discontinued	Proposal
Bolivia	Comarapa Municipality	Potentially ongoing but no info	
Bolivia	ICO	Borderline	
Bolivia	Los Negros	Ongoing	
Bolivia	Prometa (HEP)	Potentially ongoing but no info	
Bolivia	San Pedro (GTZ)	Advanced proposal	
Bolivia	Sucre (GTZ)	Advanced proposal	
Bolivia	Tarija	Ongoing	
Bolivia	Vallegrande municipality	Potentially ongoing but no info	
Bolivia	Watershed management programme (GTZ)	Advanced proposal	
Brazil	CPCJ	Ongoing	Pilot
Brazil	Proambiente (GTZ)	Advanced proposal	
Brazil	S Joeo Watershed (WWF)	Potentially ongoing but no info	
Chile	Water share trading and PES	Abandoned or discontinued	Proposal
Colombia	Afluentes del Cauca	Advanced proposal	
Colombia	Campoalegre	Borderline	Proposal
Colombia	Fuquene	Ongoing	
Colombia	La Miel	Advanced proposal	
Colombia	Plan Verde	Ongoing	Pilot
Colombia	Silvopastoril	Ongoing	
Colombia	Valle del Cauca	Ongoing	Pilot
Ecuador	Ambato	Ongoing	
Ecuador	Arenillas	Potentially ongoing but no info	
Ecuador	Cotacachi, Imbabura	Potentially ongoing but no info	
Ecuador	Cuenca	Ongoing	Mature
Ecuador	EcoFondo Podocarpus National Park	Advanced proposal	
Ecuador	FONAG	Ongoing	Pilot
Ecuador	Pedro Moncayo	Ongoing	
Ecuador	Pimampiro	Ongoing	
Ecuador	Rio el Angel (Cuencas Andinas)	Advanced proposal	
Ecuador	Shutan Bajo	Borderline	
Peru	Alto Mayo (Cuencas Andinas)	Advanced proposal	
Peru	Arequipa (Cuencas Andinas/GTZ)	Advanced proposal	
Peru	Jequetepeque ((Cuencas Andinas/WWF/CARE/IIED)	Advanced proposal	

Country	Name	Current Status	Status during Silver Bullet
Peru	Piura (Cuencas Andinas)	Advanced proposal	
Venezuela	Partnerships for National Parks	Advanced proposal	

8.3 Glossary of terms

Maturity of the scheme	The maturity of the scheme refers to its current status. They could be 'ongoing', proposals, borderline schemes, abandoned, or uncertain. ▪ **Borderline scheme**. These are schemes where their market component is not clear. For example, it is difficult to distinguish the buyer from the seller in intra-village arrangements. Some of these schemes were included in Silver Bullet. However, this new review puts them in a separate category highlighting their significance as examples of fair deals but with no market connection. ▪ **Ongoing schemes.** These are initiatives in which payments are being made from the users (direct and indirect), suppliers, or both. ▪ **Proposals**. Only relatively advanced proposals have been included in this review. This includes those with advanced baseline studies, stakeholders coming together in negotiation meetings, etc, but no payments are actually taking place yet. Some of these proposals take years to mature into ongoing projects, and this highlights the difficult nature of setting up payments for watershed services. ▪ **Abandoned schemes.** These schemes have been abandoned, either as a whole, or the environmental service component has been dropped for lack of support or leadership. ▪ **Uncertain schemes.** It was not possible to obtain sufficient information proving that the scheme had been abandoned or was still ongoing. Some schemes may have evolved into another local or national programme (such as the Chinese regional schemes reported in 2002), but we have not been able to confirm this.
"First generation" schemes	Initial round of market for watershed services schemes. Most of them are local and relatively isolated pilot schemes characterised by a "learning by doing" approach". Most of the schemes reported in the initial Silver Bullet publication fall in this category.
"Second Generation" schemes	Schemes are slowly beginning to take into account existing experiences and lessons from other projects. Stronger emphasis is placed on the design of baseline studies, monitoring and information sharing. Many of these schemes are subsidised by donors and tend to be part of larger regional projects such as Cuencas Andinas or the Silvopastoral Project.
Service Providers	Service providers are those stakeholders with a contractual relationship with the users, who commit themselves to implement land conservation practices in their landholdings (specifically in the water recharge area). Potential service providers are those with land in the target areas but without any contractual relationship with users or intermediaries. Kosoy, et al, 2005. ▪ Private landowners: They have clear ownership of their land, with either land titles or undisputed possession rights. ▪ Public lands: This group represents farmers living in public land (usually declared as national parks or protected areas). Farmers do not have possession rights, but manage their plots of land as private areas. ▪ Communal land: Farmers living (or drawing their livelihoods) from communal areas.

	▪ Private reserves: private landowners (individuals or groups) registered as reserves and committed to conservation of specific ecosystems.
Service Demand	Stakeholders that are interested in the provision of watershed environmental services can be roughly divided into direct demand or service users, and indirect demand or beneficiaries. ▪ **Direct demand**, or service users, is those individuals or organised groups that depend on water-based services affected by upstream land management. This group could include final consumers of domestic water (organised through private or municipal water utilities), hydroelectric projects, and water-based industry (e.g. beverages, mining, pulp or irrigation groups), as well as environmental users such as wetland users or conservation groups. ▪ **Indirect demand** for watershed environmental services may be derived from several sources, including national and local governments and international agencies. International agencies can play a key role in providing conservation or development grants to pilot schemes until downstream groups adopt payments. Alternatively, national government may wish to pool service buyers in the public interest for strategic watershed services that cannot be realistically financed by downstream demand. The Costa Rican PES programme, the South African Working for Water programme and the Chinese Sloping Land Conversion Programmes are examples of upstream payments being wholly or partly funded nationally for improved or protected public goods' provision.
Administratively-determined pricing mechanisms	An authority can determine payment levels externally. In these cases, bargaining power by landowners is limited, although they can still voice their willingness to accept by choosing not to join. This potentially can send signals back to the authority to adjust their payment levels. This type of payments is mostly used in national-level strategies.
Direct negotiation between sellers and buyers.	These mechanisms involve detailed contracts outlining best management practices, land purchase agreements and conservation easements. Direct negotiations are mostly used in situations when there are few stakeholders involved and/or are capable watershed programme already exists, direct negotiation will be easier and faster. It usually involves detailed contracts setting out best management practices, or land purchase agreements. However, payments are generally part of larger projects, and they are the result of (usually) a long bargaining process.
Negotiations through intermediary.	As the number and distribution of stakeholders increase, so does the need for an intermediary. They are used to control transaction costs and risks, and are most frequently set up and run by NGOs, community organisations and government agencies. In some cases independent trust funds are created. Intermediaries are vital in national schemes such as the PSA in Costa Rica and the PSAH in Mexico, and the final contribution from downstream users will reflect their capacity to negotiate on behalf of upstream farmers.
Pooled transactions	Pooled transactions control transaction costs by spreading risks amongst several buyers. They are also employed to share the costs of a large transaction as often required in the watershed markets.
Internal trading	Transactions within an organisation, e.g. intra-governmental payments.
Over-the-counter trades and user fees	These occur where the service is pre-packaged for sale, e.g. water quality credits. Watershed services are frequently offered at a standard rate for different beneficiaries through user fees. This rate is normally not negotiable and imposed on all beneficiaries.
Clearing-house transactions	A more sophisticated intermediary that offers a central trading platform for buyers and sellers is a clearing-house. This mechanism depends on the existence of a standardised pre-package commodity, e.g. salinity credit, water quality offset.
Auctions	Often associated with clearing-house mechanisms and over-the-counter trading, auctions attempt to move a step closer to a competitive market for watershed services. Auctions are proposed for determining the supply of watershed services as well as for allocating obligations to pay.

Retail-based trades	Where payments for watershed protection are attached to existing consumer purchases, e.g. Salmon Safe agricultural produce. Normally associated with certification and labelling schemes that generate consumer recognition and willingness to pay.
National or local government budget allocations.	National level projects, like the PSA in Costa Rica or the PHSA in Mexico, have annual government budgets allocated for payments for environmental services. In Costa Rica the main source is the 3.5% of collections from a 15% tax on fuels. In Mexico it is approximately US$20-30 million per year.
Voluntary investment from private users	Probably the most common way for companies to decide their payment levels is an internal, voluntary decision based on their own willingness to pay. In most of these cases, funding comes from the company's profits rather than transferring the cost to the final consumers, and is usually registered as 'donation' (many tax-free) in their annual budgets.
International donor support	There are many initiatives of payments for watershed services that are prompted and supported by international donors. In theory, funding is only used to provide a kick-start in the project and support the very high setting-up transaction costs. In the practice, it is unlikely that many of these initiatives will manage to raise enough local funds to be self-sustainable in the long-run.
Regulatory mechanisms	Some markets for watershed services are based in externally imposed requirements, especially in developed countries where environmental regulations are stricter. Market-based strategies are used to help companies reach environmental targets while reducing costs of compliance.
Watershed	The term watershed refers to the geographic boundaries of a particular water body, its ecosystem and the land that drains to it. It also includes groundwater aquifers that discharge to and receive discharge from streams, wetlands, ponds and lakes. Large watersheds are sometimes referred to as river basins. It is sometimes referred to as 'catchment'.
Market	Markets are defined as voluntary transactions between buyers and sellers, where the price is set on the basis of supply and demand.

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SOME IDEAS ON BUNDLING

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SOME IDEAS ON BUNDLING

INTRODUCTION

Bundling of PES is a term frequently used in the literature to link several environmental services together in order to increase income streams or reduce transactions costs. Particularly for biodiversity conservation, many authors or projects promote linking it to carbon sequestration or watershed protection benefits as a way to attract investments (Wertz-Kanounnikoff 2006). It is also suggested that bundling can help reach environmental objectives more efficiently by reducing or optimizing transaction costs.

The Tropical America Katoomba Group decided to focus on bundled PES projects in order to learn from the experiences and promote experimentation. Therefore, this document is a preliminary attempt to review the literature on the subject, list the cases where some kind of "bundling" occurs and begin to highlight some of the limitations and opportunities that the subject presents. Based on this brief analysis, a work plan is proposed to generate a lively discussion.

DEFINITIONS AND CONCEPTS

Taken from the business literature, the term bundling is a marketing strategy for joining related products. It is important to clarify what is meant by the use of the term and come to some agreement on its use in the case of PES because it seems like the term is in vogue but it might not be correct. That term seems to refer to three types of projects, which are important to keep in mind for the analysis.

Nature bundles ecosystem services and the market logic applied by PES is trying to "unbundle" these individual benefits for buyers. PES schemes aim to physically quantify the benefits generated by nature individually and monetized them for particular buyers. Those are the type of PES cases that are in process of development. Carbon sequestration being the one service that is most advanced in its technical and procedural elements.

PES cases described in the literature as "bundled" seem to be of two types:

a) those that conceptually bundle projects, meaning that the description and conceptualization of the project links more than one service, but they are not all quantified and monetized. This effectively is a rhetorical category.
b) those that effectively do bundle services and are quantified in the price that the buyer pays. This is the case of the GEF WB Regional Integrated Silvopastoral Ecosystem Management Program project where the project, in this case the international community interested in conservation, is paying for biodiversity and carbon benefits. This category is exceptional at this time but could be an interesting market for public donors, national and regional governments. There are efforts being developed towards this end in Australia, UK and some states in the US (www.ecosystemservicesproject.com).

Finally, the third category that seems to emerge are the cases where bundling of support services occurs for the producer. The stellar case is FONAFIFO that though it sells services individually, it has developed the skills, know-how, methods and procedures that are applicable to many PES.

Considering these categories, it is important to review what the marketing information on bundling suggests. According to Wikipedia, a bundling marketing strategy is most successfully applied under the following conditions:

- "When there are economies of scale in production,
- When there are economies of scope in distribution,
- When consumers appreciate the resulting simplification of the purchase decision and benefit from the joint performance of the combined product,
- When the marginal costs of bundling are low.
- When production set-up costs are high,
- When customer acquisition costs are high."

These two initial conditions could be informative for our current discussion. It is important to highlight that conceptually economies of scope are the same as economies of scale but while the first refers to the supply-side, the second refers to the demand-side of the market. Economies of scale mean expanding the scale of production, which in this context can be the geographical area where the ecosystem service(s) occurs. Economies of scope are efforts to find efficiencies in marketing and distribution of different types of products, in this case support services for producers of ecosystem services.

So, the use of the term bundling might be wrong in some circumstances and right on in others. It maybe convenient to explore if there is another term that is most adequate for the cases where bundling does not occur.

SELECTED CASES IDENTIFIED

For the purposes of this short review, emphasis has been given to the four most common services being currently addressed internationally: carbon sequestration, watershed services, biodiversity and landscape beauty.

The cases identified as "bundled" are a result of existing reviews of PES underway or proposed (Pagiola et al. 2002, Mayrand K. and M. Paquin. 2004; Wunder, 2006). The author had access to the International Institute for Environment and Development database used for the global review (Landell-Mills and Porras, 2002). Also, CIFOR provided a draft report of a study currently underway in Colombia and Venezuela that reviews experiences (Blanco, Wunder and Navarrete, 2006).

Due to time restrictions, the geographical focus is Latin America, which is the experience known by the author. However, Rewarding Upland Poor for Environmental Services network promoted by the World Agroforestry Center (ICRAF) and the Sustainable Financing and Payment for Environmental Services lead by WWF – Macroeconomic Finance Program still needs to be reviewed. Therefore, this is an initial list of cases that needs to be completed with reader suggestions and as a result of the ERT Symposium to be held in Cartagena the 18 and 19th of February in conjunction with the TAKG Steering Committee meeting. All suggestions are welcomed.

The working definition of Payment for Environmental Services was strict in order to capture really "bundled" experiences. The Katoomba Group activities focus on the broad range of formal and informal contracts that give financial and economic value to stewardship services- from one on one informal agreements, to large scale systems that shift economic investments in land stewardship.

As illustrated in the Table, there are few examples of joint PES schemes. Rather, a service is well documented, such as carbon, but the additional benefits from a second service (say biodiversity or water) are assumed. The exception is the GEF funded Regional Integrated Silvopastoral Ecosystem Management Program, which has developed a methodology and tested the payment scheme for biodiversity conservation and carbon sequestration in Colombia, Costa Rica and Nicaragua. Based on indicators that are monitored, they have developed coefficients that affect the actual payment made to landowners. As seen in the USDA case buyers for these bundled services will probably be governments, rather than private, who may have a specific interest in a particular service. However, the case of Hancock Corporation in New South Wales, needs to be studied further.

For bundling for sellers, the list included the case of institutional arrangements that aggregate buyers and/or sellers, such as FONAFIFO. Established in 1991 under the Ministry for Environment and Energy (MINAE) in Costa Rica, FONAFIFO, the National Forestry Finance Fund, which as the name highlights focused on forestry sector measures, broadened its scope to encompass payments for environmental services as a source for financing the sector. Though payments recognize services offered by natural forests and forest plantations, such as carbon, hydrological benefits and landscape beauty, they are paid individually, not bundled. However, responsible for financial administration and payments to landowners, FONAFIFO highlights the potential of a government initiative for PES market development.

Another interesting case included is Fundación para Conservación de Bosques, an entity recently created in Ecuador by PROFAFOR for conservation of highly threatened forests. After having the longest standing experience in payment for carbon sequestration service in plantations (23,000 has) paid by Dutch power producers, PROFAFOR received funds to pay economic incentives for conservation. It would seem that the motivation of the project is learning-by-doing on avoided deforestation measures. It is clear that the know-how made with carbon contracts provided *an economy of scale* for developing biodiversity conservation contracts.

FONAG, Quito´s water fund, has the potential to act like a FONAFIFO. Initially created to provide resources from water users for the protection of the watersources located in important biodiversity spots, 3 national parks, the institutional and financial mechanism can eventually integrate other services, such as carbon from reforestation. This case is not a strict PES scheme and is only in the process of developing its baselines for water and biodiversity protection. Many countries now have financial entities to support their national park system, which could become interesting vehicles for channeling PES. Yet, their structures and functionality is varied and not all aim to insert this into their agenda.

CASE	COUNTRY/ PROPONENTS	ECOSYSTEM SERVICE 1	ECOSYSTEM SERVICE 2 OR 3, 4	COMMENTS
BUNDLED PES				
USDA's Conservation Reserve Program	USA – US Dept. of Agriculture	Biodiversity protection	Water quality, erosion control, air quality, etc.	Payments of up to $50,000 per year allowed. Additional up to 50% cost of establishing cover and separate incentive payments for restoring wetlands. (IIED Database)
Hancock New Forests	Australia - New South Wales – companies and institutional investors	carbon	biodiversity, and salinity credits	Need up to date info. (IIED Database)
Regional Integrated Silvopastoral Ecosystem Management Program, a GEF/WB funded project (Inweb18.worldbank.org/ESSD)	Costa Rica, Nicaragua y Colombia – Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Instituto Nitlapán y Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria (Fundación CIPAV)	Carbon	Biodiversity (species diversity, increased wildlife population)	Farmers receive an up-front payment that can be (<$500 per point) plus annual payments for two-to-four year periods ($75 to $110 per point). Total payment can not exceed $6,500 per landowner. Extensive monitoring system in place to document changes in land use, improvement in biodiversity conservation and prevent perverse incentives. (Blanco, Wunder & Navarrete 2006)
CONCEPTUALLY BUNDLED				
Climate Action Project: Noel Kempff Mercado National Park	Bolivia – partnership with the Government of Bolivia, Fundación Amigos de la Naturaleza (FAN), three U.S. energy companies, and The Nature Conservancy.	Reduces, avoids and mitigates up to 17.8 million tons of carbon dioxide in the atmosphere over 30 years by avoiding logging and agricultural conversion of the land.	Helps to protect 1.5 million acres of one of the most biologically diverse national parks in the world.	www.tnc.org

Rio Bravo Conservation project	Belize - TNC, Winrock International and US energy companies (Wisconsin Electrical Power Company, Detroit Edison Corporation, Cinergy, Pacificorps, Suncor and Utilitree Carbon Company)	Sequester 2.4 mtC over 40 years	Protect biodiversity through the conservation of 59,720 ha of mixed lowlands, moist subtropical broadleaf forests in NW Belize	
Bilsa Reserve Project	Ecuador – Fundación Jatun Sacha and ?	avoided carbon emissions	through the conservation of 2,000 ha of tropical forest in the Montañas de Mache Chindul	Incomplete. IIED Database
Ecotourism & conservation in Sikkim	India - Travel Agents Association of Sikkim (TAAS) and Sikkim Himalayan Integrated Environment Protection Society	Biodiversity conservation	Landscape beauty	200 community members in four settlements prepare and implement ecotourism plans that set out a range of conservation activities, including trail clean-ups, tree planting, fuelwood substitution. IIED Database
BUNDLED SUPPORT SERVICES FOR SELLERS/BUYERS				
FONAFIFO	Costa Rica			Investment of US$ 14 million to protect biological diversity, mitigate greenhouse-effect gases, and favoring water services, which resulted in reforestation of 6,500 ha, sustainable management of 10,000 ha of natural forests and preservation of 79,000 ha of private natural forests (Nasi et al. 2002).
Fundación Bosques para la Conservación	ECUADOR – FACE, PROFAFOR and Forests Forever	Biodiversity($5/ha)	*Carbon (avoided deforestation)*	This experience is managed by PROFAFOR who has reforested 23,000 has as part of AIJ.
FONAG	ECUADOR	Watershed services (%1-2 drinking water sales)	Biodiversity (park guard fund to protect watersouces in 3 national parks)	Not measured.
Water Fund for the Mt. Guiting-Guiting Natural Park	PHILIPPINES – Municipality of San Fernando and WWF	Watershed services	Biodiversity (patrol and reforestation activities for landowners)	Incomplete info. (PES InfoExchange, June 2006)

EMERGING ISSUES

Ecosystem Synergies and Trade-offs

To validate the use of the term, it is important to explore if there is an "economy of scope" in distribution for PES, which seems to be the reason why bundling has been of great interest. Particularly for biodiversity proponents, water flow and quality and carbon are considered potential "hooks" for customers. The assumption is that in a given area, land cover will provide the services mentioned. Unfortunately, there is recent evidence that this may not be the case. A study in California (Chan et al 200, found low correlations between biodiversity and six other ecosystem services (carbon, water provision, forage production, pollination services, recreation and flood control). Measuring the potential provision of each of the six services, the study found that they reach their full potential production at the different geographical locations. Therefore, their coincidence to a primary ecosystem service, as in this case biodiversity, is very low and at times inexistent.

However, when the study analyzed each service and their bilateral correlations, the results were more positive. There are better correlations geographically among two particular services; for example, the highest correlation was found between carbon and water provision. Further data is necessary to come to conclusions, but it introduces a note of caution for bundling services. At the same time, highlights the importance of understanding the synergies and tradeoffs among individual services.

It is also important to consider the measures being implemented to insure a particular service. For example, there is growing concern about carbon sequestration strategies that promote plantations but do not evaluate all their potential environmental impacts. In an article in Science, Jackson et al (2005) found that afforestation reduces stream flow and increases soil salinization and acidification in the US. An expert meeting held at Duke University to review the results of this study (Olander 2006), highlighted the fact that the study focused on plantations and "did not assess the affects of mixed species and natural reforestation of deforested areas." This observation is very relevant as well for the review of the literature on the watershed services provided by forests and it is something to keep in mind to explore synergies and tradeoffs. The US Forest Service just published a white paper on forests and ecosystem services that can provide more information (Notman, E. et al. 2006).

Results in tropical areas may be different and more synergies maybe found. Efforts underway at CATIE, University of Bonn and ETH-Zürich, using data from Costa Rica may shed more light on this discussion. Also, studies conducted in more pristine settings may demonstrate more complimentary results. Wunder (2006) has argued that PES are more likely to succeed in areas where there are risks of threats and those landowners maybe more open to receive payments, rather than those that are already conserving.

Buyer and Seller Aggregation benefits

A potential justification for bundling responds to issues pertaining to "economies of scale" for support services and management of buyers and sellers. In the cases where synergies are found, the marginal cost of designing, developing and monitoring an additional ecosystem service B maybe lower for a particular institutional or financial mechanism that is in place for the sale of ecosystem service A. In other words, if the hydrological service only needs good standing forests and already the biodiversity service is insured, then the first service is free. But even if the provision of the service is free, the hydrological monitoring and other related tasks, which are needed to verify the existence of the service, do cost (pers. Comm. Carlos Muñoz). The question becomes what is the most effective multiple-PES entity (a clearing house or fund) that can provide the needed support services at a lower cost than individual transactions. This is relevant for all the issues pertaining to transaction costs, which is another loaded term.

Despite the risk of becoming too bureaucratic for forestry projects, the carbon model demonstrates the importance of developing concepts and procedures to regulate the market of this service (Kägi and Schöne 2005). Considerations such as additionality, permanence, leakeages and sustainable development goals are relevant for other ecosystem services. With opening of the opportunity to include avoided deforestation again in the carbon regime, it is important to avoid "Kyotization" of PES, but at the same time apply the rigor that the concepts and procedures can provide. A specialized entity to confront these technical challenges can improve the likelihood of success of these environmental instruments. FONAFIFO has demonstrated the benefits of having a centralized entity for PES that has shown to be able to evolve over time and experiment.

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Global Habitat Protection:

Limitations of Development Interventions and a Role for Conservation Performance Payments

Global Habitat Protection: Limitations of Development Interventions and a Role for Conservation Performance Payments

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Abstract: *Conservation biologists, policy makers, and citizens have identified the protection of native ecosystems in low-income nations as a global social objective. Among the more popular initiatives toward this objective is the use of development interventions in the peripheral areas of endangered ecosystems. Such interventions indirectly provide desirable ecosystem services by redirecting labor and capital away from activities that degrade ecosystems (e.g., agricultural intensification) and by encouraging commercial activities that supply ecosystem services as joint products (e.g., ecotourism). I examined the economics of such interventions and the available empirical evidence and concluded that development interventions are hindered by (1) the indirect and ambiguous conservation incentives that they generate, (2) the complexity of their implementation, and (3) their lack of conformity with the temporal and spatial dimensions of ecosystem conservation objectives. In contrast, paying individuals or communities directly for conservation performance may be a simpler and more effective approach. In recent years there has been widespread experimentation with contracting approaches to ecosystem conservation. Conservation contracting can (1) reduce the set of critical parameters that practitioners must affect to achieve conservation goals, (2) permit more precise targeting and more rapid adaptation over time, and (3) strengthen the links between individual well-being, individual actions, and habitat conservation, thus creating a local stake in ecosystem protection. In situations where performance payments are unlikely to work, indirect development interventions are also unlikely to work. Thus, despite the potential barriers to developing a system of conservation contracts in low-income nations, my analysis suggests that performance payments have the potential to improve the way in which ecosystems are conserved in these nations.*

Protección Global del Hábitat: Limitantes para el Desarrollo de Intervenciones y el Papel de los Pagos por la Ejecución de Actividades de Conservación

Resumen: *Los biólogos conservacionistas, los legisladores y los ciudadanos han identificado la protección de ecosistemas en naciones con bajos ingresos como un objetivo social global. Entre las iniciativas más populares para alcanzar este objetivo se encuentra el uso de intervenciones para el desarrollo en áreas periféricas de ecosistemas en peligro. Estas intervenciones proveen servicios deseables del ecosistema indirectamente al re-direccionar actividades y capital lejos de las actividades que degradan el ecosistema (por ejemplo, intensificación agrícola) y alentando actividades comerciales que provean servicios del ecosistema como los productos de coyuntura (por ejemplo, ecoturismo). Examiné la economía de estas intervenciones los y las evidencias empíricas disponibles y concluí que las intervenciones de desarrollo son entorpecidas por (1) incentivos indirectos y ambiguos que generan; (2) la complejidad de su implementación y (3) la carencia de concordancia con las dimensiones temporales y espaciales de los objetivos de conservación del ecosistema. En contraste, el pago directo a individuos o comunidades por la ejecución de la conservación podría ser una estrategia más simple y más efectiva. En años recientes, ha habido amplia experimentación con las estrategias de contratación para la conservación de ecosistemas. Los contratos para conservación pueden (1) reducir el conjunto de parámetros críticos que los practicantes deben afectar para alcanzar las metas de conservación; (2)*

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permitir el establecimiento de metas más precisas; y (3) fortalecer los vínculos entre el bienestar individual, las acciones individuales y la conservación del hábitat, creando asi un interés local en la protección del ecosistema. En situaciones donde los pagos por rendimiento no son viables de funcionar, las intervenciones de desarrollo indirecto probablemente tampoco funcionen. Por ello, a pesar de las barreras potenciales al desarrollo de desarrollar un sistema de contratos de conservación en naciones de bajos recursos, mi análisis sugiere que los pagos por rendimiento tienen el potencial para mejorar la forma en la que los ecosistemas son conservados en estas naciones.

Introduction

Imagine that you live in a house that needs no air conditioning because the trees on your neighbor's property provide shade to cool your home. Recently, however, a new person moved into your neighbor's house. He wants to cut down the trees because he has installed solar panels to reduce his electricity bills. Cutting down the trees will increase the efficiency of the panels but will require you to install air conditioning and pay much higher electricity bills. Your uncle suggests a plan for ensuring that your neighbor's trees remain standing. He suggests that you create alternative employment and investment opportunities in which your neighbor's returns to labor and capital are so high that he will not want to invest time or money in cutting down his trees.

You may, however, decide that it is easier, and probably cheaper, to simply offer your neighbor an annual payment to leave the trees standing. The payment would have to be large enough to compensate your neighbor for the foregone reductions in his electrical bills, but it would probably be far less than the cost of occupying your neighbor's resources in other activities. Moreover, the probability that the trees will remain standing is higher.

Paying your neighbor to leave his trees standing because they provide a valuable service would strike few people as misguided. In low-income nations, however, citizens and governments interested in habitat and biodiversity conservation have adopted your uncle's less direct and more complex approach. Rather than make explicit payments, they use field-based project and policy interventions to transform local and regional economies in ways that encourage individuals to invest in activities that do not lead to habitat or biodiversity loss. They propose, in effect, to guide the economic development process toward paths that are compatible with ecosystem protection.

The premise underlying these interventions is sound: if residents near a threatened ecosystem are the principal agents of change, their behavior must change to protect the ecosystem. Even if residents are not the principal agents of change, they are often in the best position to protect the ecosystem, so influencing their behavior is important. Problems arise, however, when one examines the links between ecosystem conservation and the myriad interventions proposed by conservation practitioners (e.g., agroforestry, ecotourism). I explored the logical problems associated with using development initiatives to address the loss of intact ecosystems (habitat) and the concomitant loss of biodiversity. I introduce a more direct approach that depends on explicit payments tied to conservation results.

The purpose of this paper is to draw attention to and generate discussion about a system of direct payments for achieving ecosystem conservation objectives in low-income nations. I emphasize the positive aspects of direct payments but do not ignore problems associated with such systems. I hope this paper can serve as a foundation for examining direct-payment systems more thoroughly.

Development Interventions for Ecosystem Conservation

I focus on field-based interventions, such as technology transfers, that target individuals living near an ecosystem. Broader policy interventions, however, are clearly important in low-income countries. Ecosystem degradation is often stimulated by road building in remote areas, by direct and indirect subsidies for production activities, and by policies that encourage farmers to clear land to avoid taxes or gain property rights. Changes in these policies are thus necessary for ecosystem conservation but are unlikely to be sufficient. In the best cases, broad policy changes will reduce pressures on ecosystems by slowing conversion but they are unlikely to remove all of the incentives directed to individuals for converting habitat to other uses. Habitat conservation will typically require more precise, field-level incentives.

There are three principal problems associated with using development interventions to protect ecosystems. First, given the complexity of development interventions and the temporal and spatial scales at which conservation objectives must be achieved, field practitioners are forced to spread their resources over myriad tasks that often have no effect on conservation-related household behavior. Second, when practitioners do manage to have an effect, it is often an undesirable effect from a conservation perspective. Third, even if practitioners generate a desirable effect, they often have difficulty sustaining it because the effect depends on market conditions that change frequently.

Barriers to Change

Experience with development interventions over the last four decades indicates that simply raising standards of living and encouraging economic growth is a major undertaking in many countries (World Bank 1988; Porter et al. 1991). Advocates of development-based conservation interventions propose a much more difficult task. They propose, in effect, to guide or control the development process so that specific behavioral changes will occur and precise conservation objectives will be achieved. They are attempting not only to effect change but to control the precise evolution of the change.

Reviews of development projects have faulted many interventions for being too complex and too diffusely targeted to have any effect on local conditions and behaviors (e.g., Hirschman 1967:22–27; 1966 *Korry Report* cited in Copson et al. 1986; World Bank 1988; Fox 1996). A general lesson has emerged: one must keep the intervention focused and flexible and composed of a small set of tasks with a medium to high likelihood of success.

Development-based conservation interventions, however, often exhibit the exact opposite characteristics. For example, the annual work plans for five integrated conservation and development projects in Madagascar listed on average 40 key activities, not including administrative tasks (Conservation International 1995; Projet Parc National Ranomafana 1995; Volunteers in Technical Assistance et al. 1995; World Wildlife Fund 1995; Conservation International et al. 1996). Moreover, many of the tasks listed, such as intensify agriculture or develop community institutions, were likely to involve many subtasks in order to be successful.

Given the immediacy of conservation objectives and donor demands, practitioners must also achieve results quickly. Development interventions, however, rarely produce significant transformations of economies and individual behavior in the short term. New technologies, markets, and attitudes take many years to develop and slowly work their way through societies.

To reconcile the short-term immediacy of habitat conservation objectives with the slow pace of social change, conservation practitioners resort to two approaches, often in combination. The first is to regulate by force in the short term, while waiting for changes in resource use incentives to materialize. But successful development interventions depend on trust and cooperation between residents and outside technicians, and trust is difficult to engender in the presence of repressive force. The second approach involves spending large amounts of money and resources to introduce new technologies, infrastructure, and attitudes quickly. The history of development interventions in low-income nations speaks for itself: attempts to introduce multiple and simultaneous changes in technology, institutions, and attitudes typically fail (World Bank 1988; Porter et al. 1991).

The fundamental tension between the time frames of conservation and development objectives is further exacerbated by differences between the appropriate spatial scales at which conservation objectives and development interventions are realized. Ecosystems are often large and encompass many biological and cultural zones. Thus the effort to conserve them must be accomplished at a landscape scale. Development initiatives are context-specific, however, and often best begun on a small scale (Bunch 1982) or with a narrowly defined focus (World Bank 1988). When practitioners quickly introduce new technologies, markets, and attitudes at large scales, they spread their resources thinly over a large territory, thereby diluting or misdirecting their impact.

Barriers to Desirable Change

Even if conservation practitioners are able to effect change in a local economy, their interventions may not alter the incentives that prompt rural residents to degrade habitat. Rather than serving as substitutes for ecosystem-degrading activities, the new technologies and employment opportunities introduced are often complements (Ferraro et al. 1997) to these destructive activities. In other words, residents adopt the new technologies or employment opportunities (e.g., animal husbandry) but continue to engage in activities that threaten ecosystems (e.g., hunting).

Moreover, the new technologies or employment opportunities can exacerbate habitat loss. For example, contrary to the dominant hypothesis of many conservation and development projects, agricultural intensification will not necessarily take pressure off native ecosystems. In fact, some studies suggest the opposite: decreases in input prices (Ozorio de Almeida & Campari 1995; Lewandrowski et al. 1997) and increases in productivity (Wiersum 1986; Kaimowitz & Angelsen 1998; Angelsen 1999; A. D. Foster, J. Behrman, M. Rosenzweig, unpublished data) in low-income nations are associated with increases in the area of land under cultivation. Recent reviews point out that the relationship between intensification and ecosystem protection in low-income nations is indeterminate (Kaimowitz & Angelsen 1998; Lee et al. 2000).

Successful agricultural development interventions raise household incomes. More income permits farmers to purchase more labor and capital with which to further expand their activities. The needs of most people are not finite, particularly those of poor farmers. If farmers can be better off by expanding new or old technologies into intact ecosystems, they will do so. An increase in the returns to agriculture can therefore be equivalent to an increase in the opportunity costs of conservation. In such cases, conflicts between local residents and conservation practitioners will grow with increases in agricultural productivity.

Successful agricultural development interventions in rural areas typically also require improvements in transportation and market infrastructure, but a review of deforestation analyses (Kaimowitz & Angelsen 1998) found that many studies link deforestation to the proximity and quality of transport routes and markets. Better infrastructure can make pro-conservation activities more profitable, but it can also make other activities more profitable as well.

The introduction of better infrastructure and new livelihood opportunities also tends to encourage immigration into a region. Thus, even if a labor-absorbing development strategy is implemented to promote habitat conservation, the pool of labor may simply expand and render the strategy ineffective. Unless current residents have a direct incentive and the ability to protect the ecosystem from conversion, the entire agricultural sector near the ecosystem will expand. This phenomenon has been noted in case studies and general equilibrium analyses (e.g., Jones 1989; Elahl & Khushalani 1990; Coxhead & Jayasuriya 1994; Ferraro et al. 1997; Oates 1999).

A paradox seems to exist. Stagnation in the agricultural sector can put pressure on forests as farmers extensify their production and the landless migrate to the forest margins. On the other hand, agricultural profitability threatens forests by increasing incentives to clear land for cultivation. The paradox is resolved by recognizing that, at the most fundamental level, the profitability of agriculture, no matter how marginal, drives habitat conversion. Therefore, only the profitability of conservation can arrest it.

To increase the profitability of protecting ecosystems, practitioners have turned to another popular approach: market-based initiatives, such as selective timber logging or nontimber forest-product extraction, that raise the local value of intact ecosystems and thereby maintain ecosystem services as joint products. But experience to date with such initiatives indicates that success is likely only under limited conditions (Campbell et al. 1999; Salafsky et al. 1999). The task of turning remote rural residents into eco-entrepreneurs is complex, and most projects yield too few benefits for too few people to compete with activities that lead to habitat conversion (Browder 1992; Richards 1993; Lawrence et al. 1995; Smith 1996). Attempts to increase the benefits from ecosystem use often lead to the degradation or simplification of the ecosystem (Freese 1997). Even low-intensity, subsistence activities (Redford 1992) or commercial activities (Howard et al. 1996; Peres 1999) can lead to the same outcome. Moreover, the scientific data required to determine appropriate extraction levels may be expensive to gather (Freese 1997). Other authors have also noted problems related to the sustainability of extractive initiatives (Tewari & Campbell 1996; Barrett & Arcese 1998) and the inefficiencies of subsidies that are often required to make eco-activities profitable (Simpson & Sedjo 1996).

Despite the theoretical appeal of interventions oriented toward increasing the local value of intact ecosystems, the practical implementations to date have many shortcomings: they often fail to match the benefits generated by ecosystem conversion, they can lead to undesirable ecosystem simplification, and they require significant resources to implement, monitor, and sustain.

Barriers to Sustaining Desirable Change

Even if practitioners overcome the problems outlined above, an important obstacle remains: how to maintain the created system of incentives for habitat protection. Development-based conservation approaches appear to assume implicitly that one can intervene in an area, transform the local or regional economy, exit, and then watch as the transformed system rolls along in perpetuity. But societies, their economies, and their environments are never static. Prices change, roads degrade, new pests develop, and new information arrives. Development-based initiatives will therefore inevitably require repeated intervention over time. In the long term, such approaches are likely to be extremely expensive, even if they are successful in the short term.

Conservation Performance Payments

Development interventions will not make ecosystem protection optimal for rural residents in many areas of the world. As we argued above, the links that development interventions create between individual well-being and habitat conservation are often vague and indirect, or simply nonexistent. Thus conservation practitioners find it difficult to create an appropriate set of incentives and maintain them over time.

Despite the difficulties in using development interventions to promote habitat protection, conservation practitioners should not abandon attempts to change field-level incentives. As Laarman (1995) argues, the challenge is to test and ultimately implement interventions superior to our current efforts, not to discard the principles of intervention. Ideal interventions should have the following characteristics:

(1) be relatively simple in the sense that they allow practitioners to focus their energy on a few activities with high probabilities of success;
(2) achieve conservation objectives in the short and the long term;
(3) achieve conservation objectives at the scale of ecosystems;
(4) provide clear, direct incentives for residents to actively protect habitat;
(5) deter immigration; and
(6) reduce the social and political conflicts over resource allocation that often endanger ecosystem survival.

To design an intervention possessing these six characteristics, practitioners may consider an international habitat reserve program (IHRP). An IHRP is a system of institutional arrangements that facilitates conservation contracting between international or national actors and individuals or groups that supply ecosystem services. The contracts specify that the outside agents will make periodic performance payments to local actors if a targeted ecosystem remains intact or if target levels of wildlife are found in the ecosystem.

The notion of compensating people for their role in maintaining resources of global value is not new (Barbier & Rauscher 1995; Swanson 1995; Simpson & Sedjo 1996), but direct compensation schemes for individuals living near threatened ecosystems are rare because of serious obstacles to designing an effective scheme (Simpson & Sedjo 1996; Ferraro & Kramer 1997). Practitioners must deal with strategic behavior by recipients, the complexity of institutional design, conflicts over property rights, and potentially high costs of implementation. Practitioners can, however, learn from existing initiatives that pay individuals or groups for conservation performance (i.e., conservation contracts).

The best-known conservation payment initiatives are the agricultural land-diversion programs of high-income nations. In these programs, government agencies provide financial incentives to farmers to keep land out of agricultural production or shift it to alternative uses, thereby reducing the supply of agricultural commodities and augmenting the supply of environmental services. In Europe, 14 nations spent an estimated $11 billion (1993–1997) to divert well over 20 million ha into long-term set-aside and forestry contracts (OECD 1997). In the United States, the Conservation Reserve Program spends about $1.5 billion annually on contracts for 12–15 million ha, an area twice the size of all national and state wildlife refuges in the lower 48 states (Clark & Downes 1999).

These conservation contracting programs account for only a small percentage of agricultural support budgets, but they are among the fastest growing payments to farmers in high-income nations (OECD 1997). Their dramatic growth is due partly to their popularity among various stakeholders and to the opportunities they afford for flexible targeting and adjustment to local conditions (OECD 1997). Moreover, payments for enhancing the supply of environmental goods and services are likely to be one of the few government payments to rural farmers that global trade organizations, such as the World Trade Organization, will countenance (Potter & Ervin 1999).

Nongovernmental organizations (NGOs) have also developed innovative direct-payment approaches. The Delta Waterfowl Foundation, for example, has an "adopt-a-pothole" program that pays prairie farmers who protect nesting areas for ducks (Delta Waterfowl Foundation 2000). The Defenders of Wildlife (2000) reward landowners for occupied wolf dens on their property.

Although rare outside of high-income countries, direct-payment systems can also be found in the tropics. In the last 4 years, Costa Ricans have created institutional mechanisms through which local, national, and international beneficiaries of ecosystem services compensate those who protect ecosystems (Castro et al. 1998; Calvo & Navarrete 1999). Costa Rica's 1996 Forestry Law (no. 7575) explicitly recognizes four ecosystem services: carbon fixation and sequestration, hydrological services, biodiversity protection, and scenic beauty. The law gives landowners the opportunity to be compensated for the provision of these services.

Costa Rican practitioners have identified sources of financing and have developed rules for allocating available funds. Funds are allocated through the National Forestry Financial Fund (FONAFIFO), which works directly with landowners and indirectly through third-party intermediaries (e.g., NGOs). The FONAFIFO raises money from international donors and national sources, such as a fuel tax and payments made by hydroelectric plants. The FONAFIFO then distributes the money through contractual arrangements with private individuals and groups.

The FONAFIFO establishes contracts for three land-use categories: reforestation, sustainable forest management, and forest preservation. The most common contract is for forest preservation. Each category is associated with a fixed annual payment per hectare. Regional conservation agents and third-party NGOs identify potential participants based on regional conservation priorities. They often target land buffers around protected areas. Landowners who are awarded contracts receive annual payments if they comply with the contract.

Costa Rica's environmental services payment program is new, but appears to be having some success. On a June 1999 trip, I observed excess demand for conservation contracts among landowners and support for the program from many sectors. Serious issues remain, however, including minimizing transaction costs, designing and targeting contracts, and developing appropriate institutional rules and roles.

In large part, the design of a direct-payment initiative depends on field conditions and conservation objectives. In one region, targeted lands may already be in private hands. In another region, the lands may be publicly owned, but a fraction of the total land will be ceded to local residents, as individuals or as groups. For some ecosystems, a payment for preventing deforestation may be sufficient. In others, bonuses may be paid if periodic surveys indicate the presence of target levels of wildlife. In areas where wildlife are agricultural pests or injurious to humans, payments in compensation for damage may also be required (e.g., predator compensation funds of Defenders of Wildlife and the World Wildlife Fund). Despite the details that must be addressed, conservation-performance payments offer clear advantages over the use of less-direct development interventions.

Program Simplicity and Appropriate Scales

With direct payments, practitioners can focus their scarce resources on two key tasks: the design of appropriate institutions and payment schemes. With a smaller set of parameters to influence, practitioners are more likely to achieve their conservation objectives. Furthermore, they can be confident that if a contract is struck, the conservation effect will be positive.

With regard to spatial scale, performance payments are amenable to a landscape approach. For large areas that include different agroeconomic zones, the complexity of using development-based interventions to promote habitat conservation is substantial. Practitioners must tailor supporting institutions, infrastructure, and appropriate technologies to each zone. Using a contract approach, practitioners need only focus on variations in institutional arrangements across zones. Because performance payments can be targeted more precisely than development interventions, practitioners can also be more confident that their interventions will have an effect on the areas targeted for conservation (e.g., corridors) rather than elsewhere. A study of land-diversion programs (OECD 1997:48) noted that in the European Union, "Implementation is based on national and regional plans and offers opportunities for flexible targeting and adjustment to local conditions."

Performance payments are also amenable to the short time period during which conservation objectives must be met. As soon as the money and the institutions are ready, payments can be made, thus quickly establishing the link between conservation and the well-being of residents. Practitioners can sustain this link with appropriate financial and institutional design (e.g., endowments). If conditions change dramatically, practitioners can adapt and reorient by adjusting payment levels, target areas, or institutions.

Clear Conservation Incentives

With payments conditional on conservation results, the connection between conservation expenditures and objectives is unambiguous to both recipients and donors. Recipients face a clear choice: protect a parcel of land and receive payments or clear the parcel and forgo the payments. Donors may find conceptualizing and observing the effects of their expenditures easier than with development-based interventions. Funds may therefore be more forthcoming (Simpson & Sedjo 1996).

The explicit connection between payments and conservation objectives also sends a clear signal to residents that ecologically valuable land is economically valuable. In contrast, current conservation efforts often send a signal to residents that they should preemptively clear land lest it be regulated or expropriated. In the Costa Rican payment program, some observers believe that farmers without contracts are forgoing clearing forest in the hope that they may secure a contract in the future (F. Tattenbach, personal communication).

By virtue of the direct link between payments and conservation objectives, performance payments create incentives for local residents to have an active stake in protecting ecosystems. In contrast, many indirect development-based approaches (e.g., agricultural intensification) encourage passive conservation by local residents. Residents do not make a deliberate choice to protect an ecosystem; the targeted ecosystem is simply not used in productive activities and thus is not degraded. Without active local involvement in conservation, however, many ecosystems will remain open-access resources under continuous threat of conversion.

Increasing evidence indicates that private and common lands are often managed better than government lands for ecological services (Laarman 1995). This outcome is especially likely when local institutions coordinate monitoring and enforcement efforts. Of course, an important problem with private control of ecosystems is the divergence between private and social values. With performance payments, however, private agents capture social values attributed to the ecosystem and thus private and social objectives can coincide.

Although they provide clear benefits to residents, performance payments provide fewer incentives for immigration than do more diffuse development interventions. Newcomers cannot capture a share of the benefits by simply arriving in a region; they must hold a conservation contract. Contracts also eliminate the open-access character of many ecosystems by effectively allocating the land to use by local residents (i.e., for conservation). There are anecdotal examples of indigenous people gaining property rights over formerly public lands after which immigration was curtailed (Mbanefo & de Boerr 1993; Laarman 1995).

Rights and Responsibilities

In the context of performance payments, residents are cast as providers of valuable services. Their role is changed from adversary to collaborator. This change not only helps to avoid the ethical dilemma of denying poor or indigenous people the ability to earn a livelihood, but it also improves conservation enforcement by creating "citizen guards" who have an active interest in protecting ecosystems. Casting residents as collaborators can also render conservation education more effective. Residents are not told what they are doing wrong, but rather what they are doing right.

At the national and international levels, conservation contracts encourage the beneficiaries of ecosystem conservation to pay for those benefits. In particular, the participation of wealthy nations in the conservation of ecosystems in low-income nations has long been recognized as a critical component of global biodiversity protection (Article 20[2] of the Convention on Biological Diversity 1992; World Bank 1992). But a controversial aspect of development-based conservation approaches is that much of the financial transfers leave a local area through physical capital purchases and salaries of myriad expatriate and host-country experts. Direct payment initiatives ensure that more of the transfers stay in a region.

Host-country governments are also less likely to perceive performance payments as weakening national sovereignty. Industrialized nations are not pressuring low-income nations to set aside lands for protection, but rather they are engaging in a contractual agreement much like any contract for the supply of a service.

Conservation Contract Design

Although conservation contracts have advantages over less direct development interventions, they are neither easy to implement nor a one-size-fits-all intervention. Practitioners must overcome obstacles inherent in institutional design, property rights, financing, and strategic behavior by potential beneficiaries. The same obstacles, however, often play a central role in the implementation of development-based interventions. Conservation contracting has the advantage of allowing practitioners to focus their energies on overcoming these obstacles.

Institutional Design and Human Capital Investments

To design a payment program, practitioners must identify the institutions that will implement the program. Who will raise the money? Who will distribute the money? What institutions will guarantee the rights to benefits distributed by the system? Will coordination among rural residents be required; if so, how will this be accomplished? How will the legal system be made accessible to rural residents? How will statutory laws and institutions be integrated with traditional ones?

Researchers in a study of agricultural land-diversion programs (OECD 1997:48) note that while the European Union programs are successful by many criteria they "also [require] major technical and administrative expertise on the part of regional and local authorities. The lack of organisational capacity and experience could limit the potential of the programme, especially in countries that have never operated similar schemes before." Practitioners in low-income nations can learn from direct-payment initiatives in the industrialized world and Costa Rica, but the institutional requirements of a direct-payment scheme may be insurmountable in many areas.

Practitioners must also design institutions to ensure that participating rural residents receive their rightful benefits. Institutions must thwart attempts by powerful individuals to divert payments or to use the distribution of benefits as a tool to enhance their power. Experiences in low-income nations and eastern Europe suggest that preventing such outcomes is no easy task. Insofar as conservation contracting adds enforcement eyes to the system, however, direct-payment initiatives may reduce the corruption currently observed in government-controlled natural-resource management. Practitioners can also learn from recent attempts to use NGO advocates and transparent institutions to share with rural residents the revenues from tourism (Peters 1998) and wildlife culling (Muir & Bojö 1994).

Conservation contracting requires periodic payments and monitoring over time. Thus the use of performance payments implies long-lived institutions and financial support. An advantage of development-based interventions is that they seem to require only short-term investments to achieve long-term results. But as a recent World Bank analysis (Wells et al. 1999:26) noted conservation initiatives "based on simplistic ideas of making limited short-term investments in local development and then hoping this will somehow translate into sustainable resource use and less pressure on parks need to be abandoned."

Thus, despite its imposing institutional needs, a system of direct payments has many of the same institutional requirements as development-based interventions. Both require institutions that can monitor ecosystem health, resolve conflict, coordinate individual and institutional behavior, and allocate and enforce rights and responsibilities over time (Brown & Wyckoff-Baird 1992; Wells et al. 1999). Unlike more complex development interventions, however, direct payment initiatives allow practitioners to focus their resources on designing and maintaining the requisite institutions. A narrower focus will not guarantee a better outcome, but past studies of field interventions have suggested that it can help substantially (World Bank 1988; Porter et al. 1991).

Property Rights

Closely related to institutional design is the specification of property rights over the contracted areas. Given differences in conservation objectives and in biophysical, cultural, and socioeconomic characteristics across regions, there is no single correct way to specify property rights. In some areas, individuals may have or may be given full, alienable property rights. In other areas, their rights may be more circumscribed. In one situation, rights may be allocated to individuals, whereas in another case rights will be allocated to groups.

The key task in any conservation initiative is to ensure that those who invest in conservation have clear, enforceable rights to the benefits of their efforts. History demonstrates, however, that allocating (or reallocating) property rights can be an expensive and conflict-ridden process (e.g., Sobhan 1993). Moreover, without strong institutions to enforce rights, conservation contracting will contribute little to ecosystem protection. In rural areas of low-income nations, legal institutions are weak at best, and the costs of establishing and enforcing property rights may be prohibitive.

Another difficult task for practitioners is the identification of the individuals to whom property rights will be allocated. Rights must be allocated to those who can control the use of the resource. The choice of who will, and who will not, receive the rights to payments, and therefore the rights to exclude others from the resource, is open to political manipulation and can produce conflict. Allocating property rights may be one of the most serious challenges to conservation contracting. Conflict may also derive from situations in which local agents in one area receive contracts while in another area local agents are expected to provide ecosystem services free of charge. Of course, allocating rights and brokering the interests of different stakeholders have also been identified as critical components of development-based conservation projects (Brown & Wyckoff-Baird 1992).

In some countries, the rule of law, both traditional and formal, is weak or nonexistent. In such cases, conservation contracting may be impossible. In the same circumstances, however, traditional development interventions or public ownership of ecosystems are also unlikely to lead to desirable conservation outcomes.

Strategic Behavior and Displacement of Threat

Practitioners must anticipate strategic behavior by people who will attempt to extract maximum benefits from the program. For example, the promise of payments could encourage people to feign interest in converting lands that would not have been converted in the absence of payments. Residents holding contracts may also convert or harvest from substitute ecosystems that would not have been exploited in the absence of contracts. Other potential strategic behaviors include seeking short-term conservation contracts simply to overcome credit constraints and generate cash for making ecosystem-degrading investments. The potential for such behaviors, however, also exists in development-based conservation initiatives.

Residents may also try to exert market power to force conservationists to pay unusually high rents. Practitioners can mitigate the negative consequences of market power through appropriate institutional design (e.g., the Conservation Reserve Program's competitive-bidding system in the United States). Politically powerful citizens may be able to influence the allocation of contracts such that funds are not allocated to areas of high conservation value but rather to those of high political value. Such an outcome, however, is also widespread in the allocation of development investments. A transparent parcel-ranking equation based on objective criteria may help to prevent such an outcome in direct-payment initiatives.

Strategic behavior may also occur in the period prior to project implementation. If there is widespread publicity about conservation payments, wealthier and more knowledgeable individuals may engage in land speculation in the hopes of securing a large portion of the payments. Practitioners may also see an influx of immigrants hoping to be considered "residents" when property rights are allocated, or immigrants who simply do not understand that they need to hold a contract to benefit from the program.

Payment Costs

The notion of paying for people to protect habitat may strike some as an expensive proposition, but many of the regions in which conservation practitioners work are at the margins of the economy where land uses are not very profitable. Analyses of land use around protected areas indicate that residents would accept payments from $28 to $190 per year per ha to forgo the benefits of ecosystem conversion (Ferraro 1994; Shyamsundar & Kramer 1996; Smith & Mourato, unpublished data). In Costa Rica, annual payments of $35 per ha generate excess demand for conservation contracts (Calvo & Navarrete 1999).

Practitioners may also find that they do not need to make payments for an entire targeted ecosystem to achieve their objectives. They need include only "just enough" of the ecosystem to make it unlikely, given current economic conditions, infrastructure, and enforcement levels, that anyone would convert the remaining area to other uses. Thus, in a well-designed system, not only will residents protect contracted lands near their communities, but they will also protect the remaining ecosystem beyond their lands. The area that constitutes "just enough" may change over time, but with performance payments, practitioners can adjust rights and payments to maintain the required incentives.

The maintenance of biodiversity and other ecological services may also be compatible with some uses such as tourism and extraction of forest products. In these cases, payments would have to compensate residents for a subset of the foregone development options, but not for all of them. Unlike indirect investments in eco-enterprise development, however, performance payments achieve conservation objectives regardless of whether or not markets support commercial use of the ecosystem.

The absolute value of performance payments should be evaluated in light of how much money is now being spent on conservation initiatives. Some habitat conservation initiatives have spent up to $1 million per year in small areas. Few, however, have been able to dramatically change local incentives for habitat protection (e.g., Wells et al. 1992; Ferraro et al. 1997; Hackel 1999; Oates 1999; Wells et al. 1999). Considering the likely costs of using development interventions to create and maintain incentives for habitat protection, performance payments may prove very cost-effective over the long term.

With a budget equivalent to the U.S. Conservation Reserve Program in 1996 ($1.8 billion), practitioners could make annual payments on up to 60 million ha. With appropriately targeted payments across the landscape, the actual number of hectares effectively protected could easily be triple or quadruple this amount. To put this area into perspective, consider that, in 1996, 309 million ha were in World Conservation Union protected-area classes I–IV in the Middle East (including 741,000 km^2 in two Saudi Arabian protected areas), South and Southeast Asia, Central and South America, and Africa (Green & Paine 1997:13). The 25 hotspot ecosystems identified by conservationists as global priorities encompass 212 million ha (Mittermeier et al. 1999).

In the case of Madagascar, donors have proposed spending $180 million over 5 years for biodiversity and ecosystem conservation (World Bank 1996). This same amount of money could be used to make annual payments of $35 per ha on over 1 million ha of land. The forests in Malagasy parks and reserves cover just over 1 million ha (Hannah et al. 1998). Properly targeted, the money could also be used to make payments in other ecosystems and lands outside parks.

Performance payments to rural residents would not, of course, be the only costs. Practitioners and payment recipients will incur transaction costs in their efforts to design and administer institutions. For example, the administrative costs for Canada's land-diversion program (Permanent Cover Program) were estimated to be about one-quarter of the payment costs (OECD 1997). Although transaction costs in conservation contracting may be significant, many of the same costs are also incurred in development-based interventions. For example, practitioners must monitor ecosystem health and rule compliance in both interventions.

Benefits and Risks Associated with Cash Payments

When they are successful, development-oriented conservation initiatives can provide local economic benefits as well as conservation results. But performance payments also provide local benefits. In comparing the two approaches, a recent economic analysis (Ferraro & Simpson 2000) suggests that direct payments are more cost-effective conservation measures than indirect development interventions. Thus, local agents could be made better off under appropriately designed payment schemes. Moreover, performance payments benefit poor farmers by improving cash flows and providing a fungible store of wealth. For risk-averse farmers, nonstochastic payments also help to diversify the household portfolio and reduce exposure to risk. In the U.S. Conservation Reserve Program, risk reduction is an important incentive for enrollment (Gustafson 1994).

Cash payments, however, can exacerbate residents' exposure to risk by making them more dependent on markets for meeting their consumption needs. In rural areas, markets are often imperfect, and residents may not be able to transform cash into the resources they need or may be able to do so only at higher prices than anticipated. The same potential problem, however, is prevalent in commercial development interventions. In contrast to development-based interventions, however, direct-payment initiatives do not require households to make significant labor investments and thus permit them to continue production on previously cleared lands or to work off-farm. Conservation payments can thus be viewed as a complement to rather than a substitute for current income.

Financial transfers that are conditional upon stopping or limiting what may have been traditional activities can also lead to a variety of social problems. These problems, which are also prevalent in development-based approaches, become more likely the more an activity is associated with the identity of individuals, and opportunities to engage in the activity outside of contracted lands shrink. Moreover, outside observers may view conservation contracts as payments for simply doing nothing ("welfare stigma"), rather than as provision fees to local residents for ensuring the supply of valuable public services.

Conclusion

The problem of habitat and biodiversity loss is complex, but a complex problem does not always require a complex solution. Conservation practitioners may identify a hundred factors that affect ecosystem use in an area, but they need not design a hundred-pronged intervention to achieve their objectives.

Although most of the tropical world continues to experiment with indirect, hydra-headed development interventions to promote ecosystem conservation, some nations are experimenting with more direct contracting approaches that use performance payments to achieve conservation results. Conservation-contracting initiatives deserve the attention of practitioners and scholars. Although a contracting approach is neither a magic bullet nor an appropriate intervention for every site, it offers advantages to conservation practitioners in low-income countries because it

- reduces the complexity of implementation in diverse local conditions;
- achieves conservation objectives at the scale of ecosystems in both the short and long term;
- permits precise program targeting and rapid adaptation over time;
- strengthens the links between individual well-being, individual actions, and habitat conservation, thus creating a local stake in ecosystem protection;

- changes the role of local residents from adversary to collaborator; and
- encourages beneficiaries of ecosystem services to pay for the services.

An international habitat reserve program (IHRP) that facilitates conservation contracting could be an important component of a four-part global conservation strategy to (1) change policies that encourage inefficient habitat conversion; (2) generate livelihood opportunities in regions far from threatened ecosystems in order to reduce immigration and encourage emigration away from threatened ecosystems; (3) increase the perceived benefits that local, regional, national, and international citizens receive from natural ecosystems; and (4) design institutions to ensure that those who are in the best position to supply valuable ecological services benefit from their efforts.

To implement a conservation contracting initiative in low-income nations, practitioners face substantial obstacles in matters of institutional design, property rights allocation, and strategic behavior by potential beneficiaries. But the implementation of less direct, development-oriented interventions faces similar obstacles. Although there is no guarantee that a direct-payment initiative will succeed, the contrasts between direct and indirect approaches to conservation suggest that performance contracts may be one of the most effective and efficient mechanisms for protecting habitats in low-income nations. Scholars and practitioners would do well to begin experimenting with contracting initiatives in the field.

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Payments for Environmental Services in Costa Rica

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Payments for Environmental Services in Costa Rica

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Payments for Environmental Services in Costa Rica

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Abstract

Costa Rica pioneered the use of the payments for environmental services (PES) approach in developing countries by establishing a formal, country-wide program of payments, the PSA program. The PSA program has worked hard to develop mechanisms to charge the users of environmental services for the services they receive. It has made substantial progress in charging water users, and more limited progress in charging biodiversity and carbon sequestration users. Because of the way it makes payments to service providers (using approaches largely inherited from earlier programs), however, the PSA program has considerable room for improvement in the efficiency with which it generates environmental services. With experience, many of these weaknesses are being gradually corrected as the PSA program evolves towards a much more targeted and differentiated program. An important lesson is the need to be flexible and to adapt to lessons learned and to changing circumstances.

Key words

Payments for Environmental Services, Costa Rica, FONAFIFO

Introduction

Costa Rica pioneered the use of payments for environmental services (PES) in developing countries by establishing a formal, country-wide program of payments (*Pago por Servicios Ambientales*, PSA). The PSA program has been partly credited for helping the country, once known as having one of the world's highest deforestation rates, to achieve negative net deforestation in the early 2000s. Several other countries in the region have been watching this experience closely, and many are developing similar programs.

This paper examines the experience of Costa Rica's PSA program. The program's development is described in the first part of the paper. The second part assesses its effectiveness, based on currently-available evidence.

Costa Rica's PSA program

Beginning in 1997, Costa Rica developed an elaborate PES program (Castro et al., 1997; Chomitz et al., 1999; FONAFIFO, 2000, 2005). Forest Law No.7575, enacted in 1996, explicitly recognized four environmental services provided by forest ecosystems: (i) mitigation of greenhouse gas emissions; (ii) hydrological services, including provision of water for human consumption, irrigation, and energy production; (iii) biodiversity conservation; and (iv) provision of scenic beauty for recreation and ecotourism. The law provides the regulatory basis to contract landowners for the services provided by their lands, and establishes the National Fund for Forest Financing (Fondo Nacional de Financiamento Forestal, FONAFIFO).

The PSA program did not start from a blank slate. Beginning in the 1970s, concern over dwindling timber supplies led Costa Rica to provide incentives for timber plantations, initially through tax rebates. The Forest Credit Certificate (Certificado de Abono Forestal, CAF), created in 1986, broadened participation, which had previously been limited to larger companies with significant tax liabilities. Several variants of the CAF were introduced over the years. The introduction of the Forest Protection Certificate (Certificado para la Protección del Bosque, CPB) in 1995 was particularly significant, as it supported forest conservation rather than timber production. Over 150,000 ha received financing through the old system.[1]

When the PSA program was created, therefore, Costa Rica already had in place a system of payments for reforestation and forest management, and the institutions to manage it. The Forest Law built on this base, with two major changes. First, it changed the justification for payments from support for the timber industry to the provision of environmental services. Second, it changed the source of financing from the government budget to an earmarked tax and payments from beneficiaries. In other respects, the PSA program was very similar to previous forest sector incentives. Until 2000, the activities financed under the PSA program closely paralleled those financed by previous instruments: timber plantations, sustainable forest management, and forest conservation. Many details of implementation, such as payment amounts and scheduling, were also carried over from earlier programs. Indeed, at first CAF certificates were used to pay PSA program participants.

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[1] All figures for which no specific source is indicated were provided by FONAFIFO.

Over the years, the PSA program has evolved considerably. In 2000, the array of instruments was simplified to only two: timber plantations[2] and forest conservation[3]. An agroforestry contract was introduced in 2004, and a natural regeneration contract is being introduced. Initially completely untargeted, the PSA program is moving towards a greater degree of targeting. On the demand side, FONAFIFO has secured agreements with many water users to pay for watershed conservation, and developed streamlined instruments to facilitate this. It was an early entrant in the global carbon market.

The PSA Program is managed by FONAFIFO, a semi-autonomous agency with independent legal status. FONAFIFO's governing board is composed of three representatives of the public sector (one each from the Ministry of Environment and Energy, the Ministry of Agriculture, and the National Banking System) and two representatives from the private forest sector (appointed by the board of directors of the National Forestry Office). FONAFIFO's status gives it a relative degree of autonomy in making personnel decisions and in managing funds, but it remains subject to a variety of governmental restrictions. Its budget must be approved by the Ministry of Finance, while payment levels and priorities are set annually be executive decree. Delays in these administrative procedures have often hampered FONAFIFO's work.

Who pays for the PSA program?

To date, the bulk of PSA program financing has been obtained by allocating to FONAFIFO 3.5% of the revenues from a fossil fuel sales tax (about US$10 million a year).[4] From 2001 to 2006, the PSA program was supported by a loan from the World Bank and a grant from the Global Environment Facility (GEF), through the Ecomarkets Project. A new project, Mainstreaming Market Based Instruments for Environmental Management (MMBIEM), will continue supporting the program from 2007.[5] The PSA Program has also received a grant from German aid agency KfW through the Huetar Norte Forest Program.[6] Efforts have also been made to charge various service users for the services they are receiving. Ultimately, it is envisaged that all beneficiaries of environmental services would pay for the services they receive. As discussed below, this objective has been met only partially to date, though progress is being made.

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2 This contract is called a 'reforestation' contract by FONAFIFO, but is intended to produce commercial timber plantations. To avoid confusion over its intent, it will be called the 'timber plantation' contract herein. The distinction is also important because, by law, critical areas such as steep slopes and riparian zones cannot be exploited commercially. These areas, therefore, are not eligible for the 'reforestation' contract.

3 The forest conservation contract is also often refered to as the 'forest protection' contract.

4 Initially, the PSA program was to receive one third of fuel tax revenues, but conflicts with the Ministry of Finance meant that only a small and variable part of these funds were actually received (FONAFIFO, 2000). Subsequently, Fiscal Reform Law No.8114 of 2001 reduced FONAFIFO's share of fuel tax revenues to 3.5%, but guaranteed this amount.

5 In both the Ecomarkets and the MMBIEM Projects, the GEF grants represent additional resources for the PSA program, but the Bank loans do not. As discussed below, the GEF grants can be considered payments from biodiversity users.

6 The EUR10.2 million (US$11.9 million at the 2003 exchange rate) grant was received in 2003, but was made retroactive to 1999 by reimbursing FONAFIFO for earlier contracts it had entered into in anticipation of receiving the grant. This grant is essentially a traditional aid/development grant, which is implemented through the PSA program (an existing mechanism and a trustworthy institution up-and-running in the receiving country), rather than a conscious effort to pay for environmental services (G. Mes, pers. comm., 2005).

Water service payments

Forest Law No.7575 explicitly recognized the role of forests in providing hydrological services. Payments from hydropower producers and other water users were always envisaged as one of the legs on which the PSA program would stand. Law No.7575 does not obligate beneficiaries to pay for services, however. Any payments must be negotiated with potential service buyers. FONAFIFO has dedicated substantial efforts to negotiating with water users for them to pay for the water services they receive and has reached a number of agreements (Table 1).

A first agreement, with hydropower producer Energía Global, was reached in late 1997 with the assistance of FUNDECOR, an environmental NGO. Under this agreement, Energía Global contributes to payments made to participating land users in the watersheds above the company's two run-of-the-river powerplants. Similar agreements were reached a year later with other hydropower producers, including state power producer Compañia Nacional de Fuerza y Luz (CNFL).

After a slow start, the number of financing agreements with water users rose sharply, helped by the development of a streamlined process based on environmental services certificates (Certificados de Servicios Ambientales, CSA) which are standardized instruments that pay for the conservation of one hectare of forest in a specified area. Rather than negotiating each agreement on an ad hoc basis, FONAFIFO can sell interested water users the appropriate number of certificates. Recent agreements include bottlers, municipal water supply systems, irrigation water users, and hotels. The amounts paid have also risen: early agreements saw water users paying for a quarter of conservation costs (based on the notion that water services are one of four services that the law said forests provide), while recent agreements involve water users paying the entire cost of conservation, as well as covering FONAFIFO's administrative costs. Agreements with water users are typically for five years.

In 2005, Costa Rica expanded the use of water payments by revising its water tariff (which previously charged water users near-zero nominal fees[7]) and introducing a conservation fee earmarked for watershed conservation. Once fully implemented, this fee will generate an estimated US$19 million annually, of which 25% (about US$5 million) would be channeled through the PSA program, the balance being allocated to the Ministry of Environment and Energy's Water Department (50%) and to protected areas (25%) (Fallas, 2006). This new tariff was instituted by Presidential decree, and will be embedded in a new Water Law which is under consideration in the National Assembly.

The water tariff represents a shift from voluntary agreements to compulsory ones. It will result in a rapid and substantial increase in the amount of funding available for conservation. After five years of efforts, voluntary agreements generated about US$0.5 million annually. In a similar time period, the water tariff is likely to generate ten times the amount.

The move to compulsory payments has an important downside, however. In addition to funds, payments made under voluntary agreements, also generate information—on which areas are important for water supply, and on what kinds of services need to be protected. Voluntary agreements also contain an explicit feedback loop, as water users can withhold payment if they

[7] The discussion here centers on the fees that holders of water use permits pay to the government for the right to extract or use water, not to the fees paid by consumers. Hydropower producers, for example, paid 0.001 centavos/m^3 under the previous tariff.

do not receive the desired services. Neither of these desirable characteristics is present in the case of compulsory payments such as those mandated by the new water tariff. As fees are uniform nationwide (for a given type of user), prioritization must depend on FONAFIFO undertaking its own studies of conservation needs—and getting them right. And as payment of fees is compulsory, water users have no leverage to request changes if the program fails to improve water services.

Several features of the Costa Rican water tariff help reduce the extent of these problems. First, revenue from the tariff must be used in the watershed within which it is generated, and to benefit water users. This helps ensure that resources are used where water needs are greatest. Second, water users can deduct any direct payments to FONAFIFO from the amounts due under the water tariff.[8] This ensures that water users do not pay twice for conservation, once through the voluntary agreement and once through the tariff. In fact, this feature may result in an increase in voluntary agreements. By paying FONAFIFO directly, water users can ensure that their payments go to agreed purposes, rather than leaving the choice of activities entirely up to FONAFIFO.

Biodiversity payments

The Ecomarkets Project included a US$8 million grant from GEF, which can be considered a payment from the global community for the biodiversity services provided by Costa Rica's forests. US$5 million of this grant were used to make payments in biodiversity priority areas and the balance for institutional strengthening. Another GEF grant, for the Costa Rica component of the Regional Integrated Silvopastoral Ecosystem Management Project, is also channeled through the PSA program (Pagiola et al., 2004, Ibrahim et al., 2006). This project aims to generate both biodiversity conservation and carbon sequestration benefits by using a PES mechanism to encourage the conversion of extensive pastures to silvopastoral land uses. The recently approved MMBIEM Project includes a further US$10 million grant from GEF. Conservation International (CI) is also paying for biodiversity conservation through the PSA Program, by providing US$0.5 million to pay 50% of the cost of agroforestry contracts in the Osa and Amistad Pacifico conservation areas; and by paying 50% of the costs of planting up to 80,000 trees under agroforestry contracts in the buffer zone of Chirripó National Park.

Unlike agreements with water users, 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 yet borne fruit.[9] This creates a challenge for funding long-term payments to service providers in areas where neither water nor carbon payments are available. Within the 1.4 million ha of biodiversity priority conservation areas outside the protected areas, about 0.2 million ha have significant potential for carbon financing, and about 0.3 million ha have significant potential for water financing, leaving about 0.9 million ha that do not have potential for either water or carbon financing. An endowment fund is being established to provide a partial answer to the challenge of funding long-term payments for conservation in this area (Pagiola et al., 2006).

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8 This feature means that the net increase in resources available to FONAFIFO will be less than US$5 million, as part of the roughly US$0.5 million that FONAFIFO already receives from water users will count against that. However, water users who are currently paying more than the tariff would require them to have signalled their intention to maintain the higher payment levels.

9 Several hotels are paying for watershed conservation (see Table 1), but they are doing so to protect their water supplies, not to preserve biodiversity.

Carbon payments

Fuel tax revenues can arguably be considered a payment from Costa Rican carbon users for the carbon sequestration benefits provided by the PSA Program. As with

From the beginning, Costa Rica's PSA program has also sought to sell carbon emission reduction credits. PSA contracts specify that the rights to any resulting emissions reductions belong to FONAFIFO. To sell these emissions reductions, FONAFIFO developed a standardized instrument, the Certifiable Tradeable Offset (CTO), which represented an externally certified 1-tonne net reduction in carbon emissions (Castro et al., 1997; OCIC, 1999). The program got an early boost when the Norwegian Government and a consortium of Norwegian power producers paid US$2 million for 200,000 CTOs. Under the agreement reached in Bonn in July 2001, however, only reforestation and afforestation are considered eligible under the Kyoto Protocol's Clean Development Mechanism (CDM). As most of Costa Rica's emission reductions are generated by avoided deforestation rather than reforestation, no additional sales of CTOs were made.

With the Kyoto Protocol now ratified, Costa Rica is returning to the carbon market. A first contract, with the World Bank's BioCarbon Fund, covers the sale of about 0.61 million tonnes of carbon dioxide equivalents (tCO_2e) by 2017. This will be achieved through a mix of planting trees in agroforestry systems, natural regeneration, and commercial plantations. FONAFIFO is also exploring the potential for 'retail' (non-Kyoto) sales of emissions reduction. Already it has sold emission reductions from conservation of 100ha of forests in Talamanca to Italian firm Lifegate, in a deal arranged with the assistance of an Italian NGO, GEV-Modena.

To help provide Kyoto-eligible carbon emissions reductions, FONAFIFO is introducing a new 'assisted natural regeneration' contract. This contract is meant to be less costly to implement than the timber plantation contract, which also produces Kyoto-eligible emissions reductions but has proven to be insufficiently attractive financially for many land users.

Landscape payments

The Forest Law mentions scenic beauty as one of the environmental services provided by forests. Negotiations were undertaken with several 'users', including hotels and a rafting company, to pay for this service, but they did not result in any agreements. Unlike water services, where there often is a single dominant user in a given watershed, the 'users' of landscape services tend to be many and fragmented, thus creating problems of collective action in securing payments.

Summary

Overall, the PSA program is only partly financed by payments from service users. The bulk of its financing is from the fuel tax, which can only tenuously be regarded as a payment by service users. The PSA Program thus remains largely a "supply side" PES Program (Pagiola and Platais, forthcoming).

Although some progress has been made towards securing financing from service users, most users are not paying for the services they receive. This includes many water users, as well as the tourism industry, despite its profiting handsomely from Costa Rica's reputation as a "Green Country".[10] Initially, the reluctance of most service users to pay for conservation could have been ascribed to lack of familiarity with the PES approach. With the PSA Program now

[10] Many tourism operators benefit directly from the PSA Program by receiving payments for their forest holdings.

well established, well-known within Costa Rica, and widely perceived as being very successful, resistance to payments is most likely due to a desire to free ride on the efforts of the government and other users. This is particularly likely to be true where multiple water users share the same watershed, or in the case of tourism industry, which is highly fragmented. It is noteworthy that all current payment agreements with water users are in watersheds where there is a single dominant user (Pagiola, 2002).[11] Moreover, some aspects of current PSA Program policies tend to discourage user payments. In the absence of direct agreements, users can count on some degree of conservation of their areas of interest through the payments made possible by government financing. When a direct agreement is reached, however, FONAFIFO generally charges *all* conservation payments in the area of interest to the user, which effectively increases the net cost of any incremental conservation (Tattenbach, pers. comm., 2005).

The proportion of the program financed by direct payments is set to increase dramatically as the new water tariff is implemented. Although this latter payment is not voluntary, it has features which help it retain some of the desirable characteristics of voluntary payments.

The program's own costs are financed from a levy of 7% of the flow of funds it handles, an amount that is fixed by law. In addition, however, some transaction costs are borne by participating land users.

How are service providers paid?

The PSA program targets private land users, with the aim of integrating environmental considerations in landscapes outside protected areas.[12] Landowners were initially contracted by the national conservation area system (Sistema Nacional de Areas de Conservación, SINAC) and by NGOs such as FUNDECOR. FONAFIFO took over this task in 2003, establishing eight regional offices to handle applications, sign contracts, and monitor implementation.

To participate, landowners must present a sustainable forest management plan prepared by a licensed forester ('regente'). These plans 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.[13] Once their plans have been approved, landowners begin adopting the specified practices, and receive payments. The initial payment can be requested at contract signing, but subsequent annual payments are made after verification of compliance (by the regentes, with a sample being audited).

Payment amounts were inherited from the earlier CAF system. For the forest conservation contract, they were about US$43/ha/year, while the timber plantation contract paid US$550/ha over five years.[14] Substantial increases in payment levels were announced in 2006, in the midst of a presidential election. Payments for forest conservation increased to

[11] The sole exception to this is the Río Segundo watershed, where Florida Ice & Farm and the town of Heredia both contribute to conservation payments, as discussed below.

[12] Private landowners in protected areas who have not yet been compensated for their lands are also eligible to participate in the PSA program. At the end of 2005, contracts with such landowners covered 38,700ha.

[13] Applicants must also comply with a variety of other conditions, such as not being in arrears with social security payments.

[14] Payment amounts are set annually, typically by adjusting the previous amounts for inflation. Annual payments for forest conservation thus gradually increased from US$40/ha in 1997 to US$43 in 2005. To reduce the impact of inflation, contracts are now denominated in US dollars rather than Costa Rican colones.

US$64/ha/year, and for plantations to US$816/ha over 10 years. Coming well before new funding sources are scheduled to be available, these increases are forcing a substantial reduction in area contracted. The net value of the payment is lower than its face value, as landowners must pay the regentes for the initial management plan and for monitoring; these fees take about 15% of payments. Complying with the provisions of their management plans (such as building firebreaks) further reduces the net value of payments. Payments offered under each contract are the same everywhere in the country.[15]

Forest conservation contracts provide for equal annual payments over the five year lifetime of the contract. These contracts are renewable by mutual agreement. In contrast, timber plantation contracts front-load most of the payment into the early years of the contract: 50% of the payment is paid in the first year, 20% in the second year, 15% in the third, 10% in the fourth, and 5% in the fifth. These contracts call for participants to continue with the agreed land use for 15 years, a restriction that is written into the land title so that it transfers to the new buyer should the land be sold.

The establishment of trustworthy contract monitoring and verification systems is an important part of any system of payments. Monitoring is undertaken primarily by the agencies responsible for contracting with farmers, including SINAC, FUNDECOR, and the regentes, with regular audits to verify the accuracy of monitoring. With the financial support of the Ecomarkets Project, FONAFIFO has established a state-of-the-art database to track compliance. Non-complying participants forfeit further payments. Regentes who incorrectly certify compliance can lose their license.

There are no specific contract conditions to prevent participants from clearing one area even as they enroll another in the PSA Program, though the ban on clearing would apply. The risk of indirect leakage seems limited. Despite the size of the PSA Program, it does not appear to have had significant economy-wide impacts (Ross et al., 2006).

Impact of the PSA program

The PSA program has been very popular with landowners, with requests to participate far outstripping available financing. Figure 1 shows the area enrolled under each contract type since 1998. At the end of 2005, about 270,000ha were enrolled in the program. Forest conservation has consistently been the most popular contract, accounting for 91% of the area covered since 1998, and for 95% of enrolled area at the end of 2005. Forest plantation accounts for 5% of total area (4% at end 2005) and sustainable forest management (now discontinued) for 4% of total area (1% at end 2005). The new agroforestry contract does not yet account for a significant area.

PES programs can suffer from various kinds of inefficiency (Pagiola, forthcoming):

Offering payments that are insufficient to induce adoption of socially-desirable land uses, thus causing socially-undesirable land uses to remain in use.

Inducing the adoption of socially-undesirable land uses, that supply environmental services, but at a cost higher than the value of the services.

Paying for adoption of practices that would have been adopted anyway.

The first two problems result in social inefficiency: in either the failure to adopt practices whose social benefits exceed their costs, or in the adoption of practices whose benefits are smaller than

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[15] There are two minor exceptions to this: a higher payment in the Río Segundo watershed, and a lower payment to landowners without title in the Río Platanar watershed (see notes to Table 1).

their costs. In both cases, social welfare is reduced over what it might have been. The third problem is not one of social inefficiency: the practices adopted are in fact socially efficient. Rather, this problem is one of financial efficiency for the program, which is generating less environmental services per dollar spent than if the problem was avoided. It can result in social inefficiency, however, in cases where funds for PES are limited: payments to land uses that would have been adopted anyway reduce funds available to induce socially-efficient land use change elsewhere. It can also result in social inefficiency if transaction costs are high, as these costs are not offset by any benefits.

The type and size of payments provided by a PES program affect the likelihood of these problems arising. Costa Rica's PSA program offers a relatively low, undifferentiated, and mostly un-targeted payment. Thus it will only tend to attract participants whose opportunity cost of participation is low, or negative. Such a program is very likely to experience the first type of problem, in which socially-desirable land use practices are not adopted because the payment offered is insufficient. Being undifferentiated and untargeted, the program will also attract many land users who would have adopted the desired practices anyway (third problem). The relatively low payments mean, however, that the program is unlikely to induce the adoption of socially-inefficient land uses on a significant scale (second problem).

Has the program affected forest cover?

The forest area enrolled in the PSA 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.

In principle, increasing the returns to forest[16] should induce a greater supply of forest. At the margin, landowners with forest areas will be less likely to clear it while landowners without forest will be more inclined to allow forest to regenerate.[17] Thus the forest conservation contract could either help avoid deforestation, or help induce (or accelerate) forest regeneration. Indeed, it can be argued that even non-participants may be induced to change behavior, as the possibility of receiving a payment in the future in itself makes forest more attractive (FONAFIFO, 2005), though this effect is clearly smaller than that on direct participants. Similarly, the timber plantation contract works by making plantations more profitable, and in particular by providing financing for initial costs and a revenue stream during part of the period prior to harvest.

Disentangling the effect of the PSA Program (and its predecessors) from that of other policy measures and broader economic trends is difficult, however. The PSA program was instituted at the same time as a package of other measures, including a ban on clearing forest land. In a sense, the PSA program was a quid pro quo for legal restrictions on clearing. Without the PSA carrot, opposition to the legal restrictions might have been much higher. Changes in the

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16 It should be noted that PSA participants incur additional obligations compared to non-participants who also maintain forest. Although clearing forest is forbidden, up to 40% of standing timber above a certain diameter can be harvested. PSA participants give up this right. Hunting is also prohibited in forests receiving PSA payments. Regentes are the primary monitoring mechanism for these restrictions.

17 In principle, only standing forests can be enrolled under the forest conservation contract. A regenerating forest would have to be about 5 years old, according to FONAFIFO, to qualify. However, there is anecdotal evidence of regenerating forests as young as 2-3 years being enrolled under this contract. Whatever the precise timing, this delay reduces the present value of payments relative to opportuntity costs. Uncertainty over whether one's application will be accepted further reduces the expected value of the payment.

profitability of livestock production had also reduced pressure to convert forests to pasture, particularly in marginal areas (White et al., 2001, Arroyo-Mora et al., 2005).

Studies have generally found that PSA recipients have higher forest cover than non-recipients. Zbinden and Lee (2005) found that PSA recipients in Northern Costa Rica had 61% of their farm under forest, compared to only 21% for non-recipients. Likewise, Sierra and Russman (2006), found that PSA recipients in the Osa Peninsula had over 92% of their farm under forest or bush, compared to 72% for non-recipients. Ortiz and others (2003) find that 36% of a sample of 100 PSA participants indicated that forest under conservation contracts had previously been used for pasture. These results are not conclusive, however, as they may be due to sample selection bias (Sills et al., 2006).

Ortiz et al. (2003) and Miranda et al. (2003) both found that many PSA participants stated they would have protected their forest even in the absence of the PSA Program. That FONAFIFO has a long waiting list of applicants willing to enroll at current prices suggests that clearing forest is not very profitable in many areas (typically, about three times as much land is offered as funds allow for). At the very least, it suggests that FONAFIFO could have enrolled a much larger area with the same budget.

Formal tests of the extent to which the PSA program has affected forest cover have given mixed results. Tattenbach et al. (2006) develop an econometric model of gross deforestation during the period 1996-2000 using district-level data from the Cordillera Volcanica Central Conservation Area (ACCVC). Using their model, they estimate that primary forest cover nationwide in 2005 was about 10% greater than it would have been without the PSA Program.[18] Sills et al. (2006) use a propensity score matching method with farm-level data from Sarapiquí from 1997 to 2000 and find evidence that PSA has encouraged protection of mature native forest. A separate test using nationwide district-level data gives inconclusive results, however. Finally, Pfaff et al. (2006) find that the PSA Program is likely to have had a minimal impact on deforestation during the period 1997-1999. It is difficult to compare these results, however, as they apply to different areas, different time periods, different dependent variables, and use different methodologies.

In assessing the incremental land use impact of the PSA program, it should be borne in mind that FONAFIFO never set incrementality as an objective. On the contrary, their approach is to 'recognize' the environmental services of whoever is providing them. If their budget was sufficient they would pay any forest owner, as all forests are thought to provide environmental services.[19]

Have environmental services been generated?

The PSA Program seeks to generate environmental services solely through forest land uses. Indeed, the very definition of environmental services in Forest Law No.7575 is "those that forests and plantations provide" (art.3). This is clearly a very blunt approach to environmental

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[18] A comparison of their estimates of avoided deforestation (108,000ha) to area under contract (270,000 ha) suggests that about 38% of forest conservation contracts actually resulted in avoided deforestation. This ratio is lowest (13%) in areas of low deforestation risk, and highest (47%) in areas of high deforestation risk.

[19] This is clearly a very blunt approach to environmental services. The Silvopastoral Project, for example, is demonstrating that the extent of benefits can vary widely from one land use to another (Ibrahim et al, 2006). The MMBIEM will assist FONAFIFO to develop a more differentiated program, with contract terms more closely tailored to specific requirements in particular areas.

services. The Silvopastoral Project, for example, is demonstrating that the extent of benefits can vary widely from one land use to another (Ibrahim et al, 2006). The introduction of an agroforestry contract marks a small move away from pure forest land uses. The MMBIEM will assist FONAFIFO to further expand the range of contracts, with supported land use practices more closely tailored to specific requirements in particular areas.

It is unfortunately impossible to determine the extent to which the PSA program has successfully generated environmental services. Although the PSA program has established a strong system to monitor land user compliance with payment contracts, the program remains weak in monitoring its effectiveness in generating the desired services.

Water services

Expectations that the PSA program's would improve water services are based on the view, well entrenched in Costa Rica as in most of Central America, that forests are always beneficial to water services (Pagiola, 2002; Kaimowitz, 2000). In fact, the evidence on the links between land use and water services is far from clear (Bruijnzeel, 2004; Calder, 1999; Chomitz and Kumari, 1998; Hamilton and King, 1983), and monitoring has not been undertaken on the impact of PSA-supported land uses on the desired water services. The primary concern in Costa Rica is over water quality, as quantity is seldom a constraint in a country that receives an estimated 170 km^3 of water annually, but consumes about 6 km^3 (AyA and OPS/OMS, 2000; FAO, 2000). Quality is particularly important as only 33 of Costa Rica's 2,069 aqueducts have treatment plants, and a further 416 have disinfection plants. Thus the majority of the 1,000 aqueducts that provide potable water do so because of the quality of the water they are drawing upon (Espinoza and others, 2003). Fortunately, the link between forest cover and water quality is much better established than that between forest cover and quantity or dry season flow (Bruijnzeel, 2004).

The growing number of contracts with water users (Table 1) indicates that many share the common perception of the benefits of forests. Most of these contracts are in watersheds that are providing satisfactory levels of water services and where forest cover is still substantially intact. Under these conditions, even if the precise link between forests and water services is unknown, a strong precautionary principle argument can be made to avoid changes that might threaten the situation. Thus the town of Heredia, which does not have a treatment plant, is paying to preserve forest cover in its watershed (Castro, 2001).

It is noteworthy that both the water service contracts that have come up for renewal have been renewed (see Table 1). That two private companies, after five years of experience paying to protect the watershed from which they draw their water, have chosen to continue the arrangement indicates that they, at least, perceive the program as working.[20] It is also significant that more recent contracts with water users have them paying the full cost of conservation in their watersheds, plus covering FONAFIFO's administrative costs, as opposed to the much lower contribution that early contracts involved.

To examine the degree to which existing PSA contracts are likely to contribute to the provision of water services, the number of contracts found in hydrologic ally important areas was examined. 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

[20] Water users may also derive other benefits from participating in the PSA program, such as social peace with upstream land users (I. Porras, pers. comm., 2005).

users. Using their estimates of avoided deforestation, they find that 644 million m^3/year of water for consumptive uses and 7,224 million m^3/year of water for hydropower production are being protected from a deterioration in quality. Thus a substantial part of the program's resources were spent in areas where few water services were likely to be generated. Moreover, only a small part of the hydrologic ally important areas was being reached. It should be recalled, however, that with the exception of payments based on contracts with individual water users (which only cover 18,000 ha, see Table 1), hydrological importance has not been a targeting criterion for the PSA program to date.

The water service agreements also indicate that the PSA program is often failing to conserve areas that could potentially generate environmental services. As can be seen in Table 1, areas conserved tend to fall short of targets—even in watersheds that have now been targeted for over five years. Although at the national scale FONAFIFO has more applicants than it can pay for, in these watersheds it is unable to find enough applicants, at the current price, to spend the budget that water buyers provide. In the Río Segundo area, to overcome high local opportunity costs, the PSA program is offering a higher price (US$67/ha, compared to the usual US$45) by cumulating payments from two local water users, the municipal water supply company of the town of Heredia, and bottler Florida Ice & Farm.[21]

The pending implementation of the water tariff will result in explicit targeting of hydrologic ally important areas, as the decree establishing it specifies that the resources it generates must be spent within the same watershed. This will be accompanied by a substantial increase in the attention paid to monitoring water impacts. Political support for the tariff could quickly evaporate if it comes to be perceived as a tax rather than a means to finance benefits to water users. To avoid this, the MMBIEM Project will assist FONAFIFO to develop operational guidelines for use of water tariff funds that seek to maximize their impact on water services, including identification of priority watersheds and critical areas within these watersheds, and specific interventions required to generate the needed services (which are likely to require the introduction of new contract forms). The project will also support the establishment of a monitoring system that will allow FONAFIFO to demonstrate to water users the benefits they are receiving, or to adjust responses in the watershed, in the event results fall short.

Biodiversity conservation services

As with water services, the percentage of enrolled area located in biodiversity conservation priority area provides a crude indicator of effectiveness at providing biodiversity services. Table 2 shows the area under conservation contracts located in biodiversity conservation priority areas.[22] The results here depend on the definition of biodiversity priority area used. Using the narrower definition of the original GRUAS report, about 30% of active contracts at the end of 2005 were in biodiversity priority areas. Using the expanded definition adopted in 2003, about 59% of active contracted area at the end of 2005 was in biodiversity priority areas. An additional 39,000 ha (3% of active contracted area) was inside protected areas,

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21 This joint payment also demonstrates that PES agreements can be reached in watersheds with multiple water users. Securing payments from water users is particularly difficult in such cases, as each individual user has an incentive to free-ride. For another example of multiple water users sharing the cost of a PES program, see Echevarría (2002).

22 A 1996 evaluation (the "GRUAS Report") defined biodiversity conservation priorities on a countrywide basis; it was later updated. It provides the primary basis for defining priority areas in the PSA Program. In addition, priority biodiversity corridors were defined under the Ecomarkets Project, and others by SINAC. They are also considered priority areas for the PSA Program, as are remaining private lands within protected areas.

and thus also in biodiversity priority areas. The proportion of contracted areas within the expanded definition has increased markedly since 2003, when FONAFIFO took over the application process from SINAC and made concerted efforts to target contract allocation. Using a slightly different definition of biodiversity priority areas, Tattenbach et al. (2006) get a similar result: in 2005, about 65% of PSA conservation contracts were in biodiversity priority areas.

With most contracts being for forest conservation, incremental impacts on biodiversity in enrolled areas depend largely on whether the program is achieving an incremental change in land cover. Using their model of avoided deforestation, Tattenbach et al. (2006) estimate that the PSA Program prevented the loss of 72,000 ha of forests in biodiversity priority areas between 1999 and 2005. The new agroforestry modality, though it only represents a small area to date, looks likely to have a significant impact on biodiversity in agricultural landscapes. The Silvopastoral Project has been documenting that land use practices with significant tree cover harbor higher levels of biodiversity than current tree-less pastures (Ibrahim et al., 2006). The number of observed diversity of bird species, as well as the number of individuals, is higher in land uses with trees, and higher yet when the tree density is higher.

Carbon sequestration services

The extent of carbon sequestration services the PSA Program has generated is driven primarily by avoided deforestation, and so cannot be estimated without better estimates of actual land use impact. Tattenbach et al. (2006), using their model of avoided deforestation and an estimate of 100tC/ha, estimate that the PSA Program avoided the emission of 11 million tC between 1999 and 2005.

How permanent are the benefits?

The long-term sustainability of land use changes promoted by the PSA program, and of any environmental services they generate, is hard to assess at present, because only the earliest contracts undertaken under the PSA have expired. In the case of forest conservation contracts—the vast majority of contracts agreed with landowners—there is no expectation of sustainability unless the contracts are renewed. Without continuing payments, landowners would clearly no longer have additional incentives to continue conserving forests.[23] FONAFIFO does intend to renew these contracts, to the extent that resources allow, except in cases where contracts were outside priority areas. In the case of plantation contracts, the expectation is that landowners will continue with the agreed land use even after payments cease. Indeed, this is a legal requirement under the contract. The reasoning here is that the PSA payment helped landowners finance the initial costs of establishing plantations, converting what would have been an unprofitable investment into a profitable one. However, reports from the field indicate that most landowners find it very difficult to maintain plantations because they do not generate any revenue in the interval between the end of the PES (in year 5) and the harvest of the timber (typically in year 20). In attempt to address this problem, both the amount and the duration of payments (to 10 years) under the forest plantation contracts were increased beginning in 2006.

The more important factor in the sustainability of the program is the sustainability of the income streams that FONAFIFO receives to make payments to land users. In this regard, it is

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[23] It is important to stress that what matters is the duration of the payment, not the duration of the contract. A contract that last relatively few years before being renewed is in many ways attractive as it permits a periodic adjustment of the terms of the contract and a re-assessment of the usefulness of contracting in specific areas. It should also be recalled that clearing forest is illegal.

worrying that the energy tax revenue is FONAFIFO's only substantial long-term income stream, as this may be threatened in the future if rising energy prices lead to pressure to reduce the tax. Individual agreements with water users are a sustainable income stream, and in this sense it is particularly encouraging that both contracts that came up for renewal to date have in fact been renewed. These payments, however, so far only represent a small portion of total funding.

The new water tariff will change this outlook, by providing a substantial additional income stream—an income stream that, moreover, is likely to be highly sustainable over time as long as the PSA program can demonstrate that it is indeed generating water services. Once fully implemented, the water tariff will provide about US$5 million a year to FONAFIFO. Carbon financing will also provide a reasonably long-term income stream for activities eligible under the Kyoto Protocol's Clean Development Mechanism.[24] As noted, an initial sale of 0.61 million tCO_2e has been made to World Bank's BioCarbon Fund. FONAFIFO hopes to generate about US$1 million a year from carbon sales by 2012.

The missing element in the long-term funding picture is biodiversity-specific funding. Both water fee revenues and carbon funding sources have restrictions (water fees can only be used in the watersheds where they are generated, carbon funding can only be used for reforestation), which would leave many areas that are important for biodiversity conservation with insufficient financing. The GEF grant under the Ecomarkets Project provided biodiversity-specific funding, but that funding has now ceased. Likewise, funds from contracts with CI are finite in time. To help assure sustainable, long-term financing of its activities in areas where water and carbon payments will be insufficient, FONAFIFO established a Biodiversity Conservation Trust Fund (Fondo para la Biodiversidad Sostenible, FBS) with the assistance of the Ecomarkets Project. This fund will receive initial capitalization from a GEF grant under the MMBIEM Project, and also serve as the repository of other grants, and of income from sales of conservation certificates in the voluntary market.[25]

Does the PSA program benefit the poor?

Although PES programs like Costa Rica's PSA are not designed to be a poverty reduction program, 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). Studies of the biological corridors targeted for GEF-financed payments under the Ecomarkets program—some of which overlap with watersheds targeted by water service payments—found them to be among the poorest areas in Costa Rica (World Bank, 2000). In recent years,

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24 That is, for reforestation and afforestation in areas deforested prior to 1990. FONAFIFO has identified about 1.1 million ha of 'Kyoto Lands' in Costa Rica.

25 There is a small but growing market for voluntary contributions to conservation. This market does not depend on either legal obligation (as in the case of firms needing to buy carbon emissions to comply with obligations, or water users being obligated to pay the new water fees) nor self-interest (as in the case of the water users that have signed contracts with FONAFIFO to finance the conservation of the watersheds from which they draw their water). Rather, this market depends largely on the personal ethical/moral choices or individual tastes, or on the desire for favorable publicity. Thus, many individuals and firms seek to offset the impact of their own carbon emissions even when they are under no obligation to do so. See Tipper (2002) for an example of a conservation project financed by sales of carbon emissions reductions to the 'retail' (non-Kyoto) market. This is not a huge market, but neither is it negligible. Costa Rica's strong 'brand name' in environmental conservation and FONAFIFO's track record mean that FONAFIFO is are well positioned to tap into this market. As noted, FONAFIFO has already made some forays into selling carbon emission reductions to the 'retail' market. It is also exploring options for selling 'biodiversity conservation' in this market.

FONAFIFO has sought to maximize their poverty impact by adding particularly disadvantaged districts to the priority areas for the PSA Program. The MMBIEM Project will also include a component specifically targeted at supporting the participation of poorer landholders in the program.

The evidence on the impact of the PSA Program on the poor to date has been mixed. Several studies (Ortiz et al., 2003; Miranda et al., 2003; Zbinden and Lee, 2005) have found that the bulk of program benefits tend to go to larger and relatively better-off farmers. Conversely, Muñoz (2004) finds that the PSA Program plays an important role in the livelihood of poor land holders in the Osa Peninsula.

A specific problem that affected the participation of the poor early in the PSA program was lack of titles. In general, titles may not be necessary for participation in a PES program as long as tenure is secure (Pagiola and Platais, forthcoming). Titles did emerge as an issue in Costa Rica, however, as national law forbade using public funds to pay landowners who lacked formal title. This not only prevented many of the poor from participating—as they were more likely to lack titles than better-off farmers—but it also impeded the effective functioning of the program by restricting participation in several important areas (Pagiola, 2002). When FONAFIFO is administering private funds, however, the legal restrictions do not apply. The solution, therefore, was to create parallel contracts, similar in all respects to the PSA contract, but financed entirely with funds provided by the service buyers, as was done Río Platanar (see Table 1). More recently, the law was changed to allow participation of landowners that lack titles.

Transaction costs are often an important impediment to participation of the poor, as working with many small, dispersed farmers imposes high transaction costs. Initially, the PSA program imposed very high transaction costs on participants, requiring applicants to fulfill eleven separate requirements, many of which—such as providing proof of payment of local taxes and that they do not owe anything to national health system—had nothing to do with their ability to provide environmental services (Miranda et al., 2003). These requirements have since been substantially reduced, by linking FONAFIFO's databases to those of other government agencies. Being current on social security payments is still a requirement, but this is now checked automatically. The PSA program also developed mechanisms to overcome the obstacles that transaction costs can create to participation by the poor. A system of collective contracting (contratos globales) was developed through which groups of small farmers joined the PSA program collectively rather than individually, thus spreading transaction costs over a large group (FONAFIFO, 2000). This approach ran into problems, however, as non-compliance by a single group member resulted in payments being halted to all members. The approach has thus been revised to process the applications of such groups together, but then issue individual contracts; this avoids the partial compliance problem, but has much smaller savings in transaction costs.

Some have argued that by making land more valuable, PES could result in politically powerful groups muscling out poorer land users who lack secure tenure (Landell-Mills and Porras, 2002). There is anecdotal evidence that this has happened in Colombia's Cauca Valley, for example. Conversely, Costa Rica's PSA program has been said to improve tenure security by preventing land kept under forest being considered 'idle' and providing protection against land invasions (Miranda et al., 2003).

Conclusions

Costa Rica's PSA program has been one of the conservation success stories of the last decade. Its approach has been widely studied, and to an increasing degree imitated. FONAFIFO has hosted dozens of official delegations from countries throughout the world who have come to study the PSA program. Mexico has established a formal PSA programs inspired, in part, by Costa Rica's example (Muñoz et al., forthcoming). As this paper has noted, however, the PSA program has many weaknesses, and it is as important to learn from its mistakes as it is to learn from its successes.

By building on the basis of previous forest subsidy schemes, Costa Rica was able to develop an elaborate, nationwide system of payments for environmental services relatively rapidly. As discussed, however, this was not without drawbacks. Many of the details of the previous schemes which were carried over into the PSA program were sub-optimal from the perspective of generating services—notably the lack of targeting and the use of undifferentiated payments. With experience, many of these weaknesses are being gradually corrected. The PSA program is evolving towards a much more targeted program, a trend that will be accelerated by the introduction of the new water tariff and by efforts to secure carbon financing. These same trends are also forcing the development of new approaches 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 other major weakness in the PSA program is its lack of data on the extent to which its activities are, in fact, generating environmental services. Only the GEF-supported silvopastoral project has monitored its impact on biodiversity conservation and carbon sequestration. 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. In particular, demonstrating carbon sequestration is a sine qua non of participation in the emerging global carbon market. Work is currently underway in this area, including one-time studies of the impact of different land uses on services and the establishment of long-term monitoring systems.

As the first effort to develop a large-scale PES program in a developing country,[26] it was inevitable that there would be mistakes in Costa Rica's PSA program. There was no instruction manual, and many of the issues involved were only dimly perceived. Even today, with much more experience in this area, there remains much to learn before we can confidently make recommendations on how such programs should be designed. We do not yet have all the answers, but we believe we have most of the questions (Pagiola and Platais, forthcoming). Perhaps the most important lesson that might be learned from the Costa Rica experience is the need to be flexible and to adapt to lessons learned and to changing circumstances.

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[26] There are earlier examples of PES approaches, notably in Colombia's Cauca Valley (Pagiola and Platais, forthcoming; Echevarría, 2002) but they were on a much smaller scale.

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Table 1: Contracts for provision of water services in Costa Rica's PSA program

Company	*Type of user*	*Watershed / Area*	*Area covered by contract (ha)*	*Actual area enrolled as of end 2004 (ha)*	*Contribution to payment to participating land users[a,b] (US$/ha/yr)*	*Contribution to FONAFIFO administrative costs*	*Comments*
Energía Global	Hydropower producer	Río Volcán and Río San Fernando	2,000	1,493	12	0	Signed 1997, renewed 2002
Platanar S.A.	Hydropower producer	Río Platanar	750	396 354	15 30[c]	5% of payment	Signed 1999, renewed 2004; addendum on non-titled land users signed 2000 for 10 yrs
CNFL	Hydropower producer	Río Aranjuez Río Balsa Río Laguna Cote	4,000 6,000 900	2,424 4,567 501	40 40 40	$13/ha yr 1 $7/ha yrs 2-5	Umbrella agreement signed 2000, with addendums covering specific watersheds
Florida Ice & Farm	Bottler	Río Segundo	1,000	440	45[d]	$29/ha yr 1	Signed 2001, later modified to use CSA
Heredia ESPH	Municipal water supply	Río Segundo			22[d]	$4/ha yr 1	Signed 2002 using CSA
Azucarera El Viejo	Agribusiness (irrigated)	Acuífero El Tempisque	550	0	45	7%	Signed 2004 using CSA
La Costeña SA	Agribusiness (irrigated)	Acuífero de Guanacaste	100	0	45	7%	Signed 2004 using CSA
Olefinas	Agricultural supplies	Acuífero de Guanacaste	40	40	45	7%	Signed 2004 using CSA
Exporpac	Agribusiness (irrigated)	Acuífero de Guanacaste	100	0	45	7%	Signed 2005 using CSA
Hidroeléctrica Aguas Zarcas	Hydropower producer	Río Aguas Zarcas	1,666	0	30	7%	Signed 2005 using CSA
Desarrollos Hoteleros Guanacaste	Tourism	Acuífero de Guanacaste	925	0	45	7%	Signed 2005 using CSA

Notes: a. In cases where contracts have been renewed, information shown on area covered and payment is that under the latest contract.
b. Participating land users receive the standard PSA contract payments (currently US$42/ha/yr) except in Río Segundo (see below)
c. Platanar pays US$15/ha/yr for contracts with landowners with land titles (285ha at end 2004), with FONAFIFO paying the rest; It pays US$30/ha/yr for contracts with landowners without land titles (385ha at end 2004), who are not otherwise eligible for PSA contracts
d. To overcome high local opportunity costs, payments by Florida Ice & Farm and Heredia ESPH are cumulated, so that land users are paid US$67/ha/yr

Source: FONAFIFO data

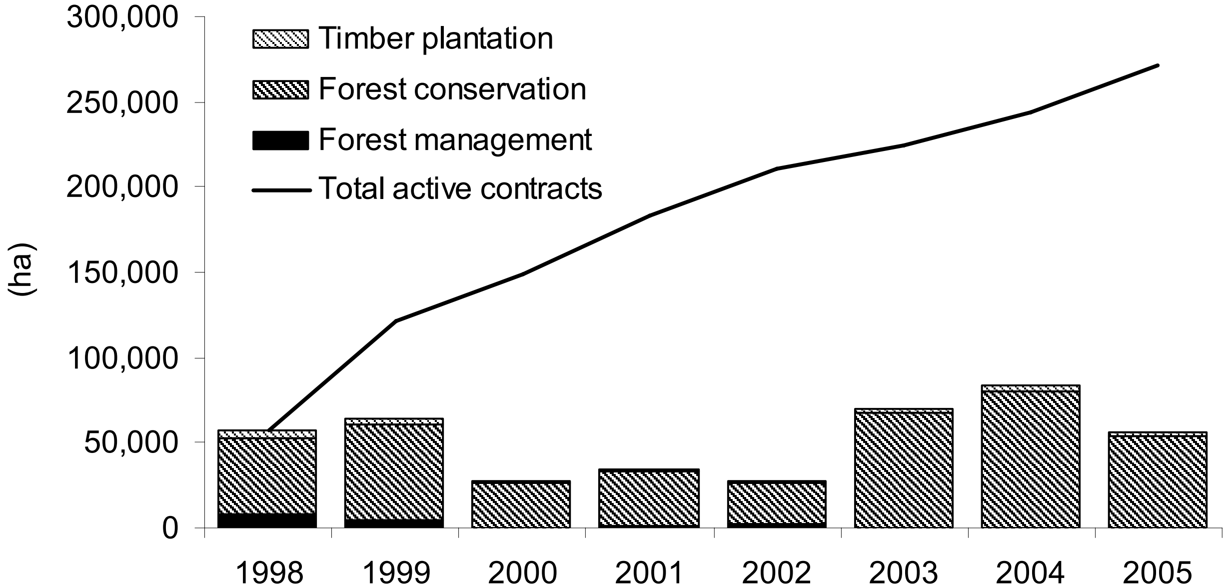
Table 2: PSA contracts in biodiversity conservation priority areas, by year of signing

	Area in new contracts (ha)				*% of total area in all new contracts*	*% of priority area covered*
	Forest conservation	*Timber plantation*	*Forest management*	*Total*		
Contracts inside GRUAS areas						
1999	13,560	159	1,181	14,900	**23.4**	1.7
2000	7,400	185	0	7,585	**27.2**	0.9
2001	6,604	212	394	7,211	**20.8**	0.8
2002	3,136	145	563	3,844	**13.9**	0.4
2003	27,664	541	0	28,205	**40.3**	3.2
2004	24,243	550	0	24,793	**29.8**	2.8
2005	15,369	447	0	15,817	**28.4**	1.8
Total	**97,977**	**2,240**	**2,138**	**102,355**		
Current	957	77,017	1,896	79,870	29.5	9.0
Contracts inside GRUAS areas, plus Ecomarkets and SINAC corridors						
1999	2,844	25,385	464	28,693	**45.1**	1.5
2000	43	12,373	777	13,193	**47.3**	0.7
2001	666	13,958	452	15,076	**43.4**	0.8
2002	1,760	7,432	533	9,726	**35.2**	0.5
2003	0	45,356	1,379	46,735	**66.7**	2.4
2004	0	52,332	1,473	53,804	**64.8**	2.8
2005	0	33,199	932	34,131	**61.3**	1.8
Total	**5,313**	**190,034**	**6,011**	**201,359**		
Current	2,426	152,277	4,770	159,473	58.8	8.2

Notes: Current contracts are active contracts at end of 2005.

Source: FONAFIFO data.

Figure 1. Total area contracted in the PSA program, by modality



Source: FONAFIFO data

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Realistic expectations of timing between conservation and restoration actions and ecological responses

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Realistic expectations of timing between conservation and restoration actions and ecological responses

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Private landowners, citizen groups, local communities, and governmental agencies invest enormous effort, time, land, and money into practices designed to conserve or restore ecosystem functions and structure. A recent survey estimated that river restoration in the United States amounts to more than $1 billion annually (Bernhardt et al., 2005a). In 1995 alone, federal expenditures on watershed-based programs to reduce agricultural pollution were estimated to exceed $500 million (General Accounting Office, 1995). Even though restoration costs are considered high by much of the public and local decision-makers, ecological benefits derived from those efforts are believed to exceed conservation and restoration expenditures (Costanza et al., 1997). For example, a study on a 72-kilometer (45-mile) reach of the Platte River estimated households along the river valued ecosystem services (water quality, soil erosion control, habitat, recreation) delivered at $19 million to $70 million annually, substantially more than the costs of conservation measures undertaken [e.g., water leasing at $1.1 million and Conservation Reserve Program (CRP) contracts of $12.3 million] (Loomis et al., 2000).

The needs, locations, and costs of conservation and restoration are constantly debated—always with passion, sometimes with information. An element frequently missing from these discussions is any realistic estimation of the time required before desired outcomes are attained (Stanford et al., 1996; National Research Council, 2002). While conservation or restoration actions are well-intended, expectations about timing of outcomes and effectiveness of such actions are often unrealistically short. As Wayne Elmore, a rangeland management scientist, noted, "Instant gratification is not fast enough for most Americans." Our objectives here are to identify timeframes over which conservation and restoration outcomes in agriculturally dominated landscapes are likely to be realized; explore landscape, ecological, and social factors affecting the definition of success for these practices; and address how conservation policies can be designed, implemented, and evaluated to yield reasonable measures of the effectiveness of these practices in agricultural ecosystems.

Conservation versus restoration

Conservation and restoration are closely related but distinct processes. Dissimilarity between these concepts has enormous consequences in terms of how success of ecological responses to management actions is defined. Conservation attempts to maintain or protect functional and ecological components of ecosystems to sustain existing resources. In contrast, restoration attempts to repair ecosystem processes and components to restore functions or structure that have been impaired or eliminated. Restoration outcomes range from minor renovation of ecological processes to attempts for complete recovery of ecosystem structure and function, which is rarely attained. Ideally, conservation maintains the performance of the existing system. Depending upon the amount of degradation and degree of recovery possible, restoration may require decades or longer to realize measurable responses. In terms of realistic expectations, one of the most critical distinctions is that conservation attempts to protect existing ecosystem structure and function; desired outcomes can thus be achieved more immediately. But a major question that must be addressed is the degree to which responses from these practices can be maintained. In contrast, restoration practices are designed to restore a portion of impaired ecosystem structure and function; thus, desired outcomes may require decades or centuries before restoration goals are realized.

In addition to substantial time lags in ecological responses potentially associated with restoration, the spatial extent and location of restoration may lead to distinct ecosystem responses. As implied by the river continuum concept (Vannote et al., 1980), this is especially true for discharge-dependent characteristics, such as flow regime, water temperature, and water chemistry. The river continuum concept suggests the relative influence of riparian shading and allochthonous inputs should decline as rivers increase in size because (1) channels generally become wider with reduced area of effective shading, (2) the amount of allochthonous riparian carbon is dwarfed by autochthonous instream carbon, and (3) increases in the volume of water passing through any particular cross-section require greater inputs of energy or carbon to significantly alter water temperature or allochthonous carbon concentrations. The river continuum concept can be used when scaling expectations of ecosystem response to restoration. For example, measurable impacts of riparian restoration at a given location on water temperature or solute concentrations should only be expected if the restored system shades the channel for a substantial fraction of its sun-exposed length or intercepts a substantial portion of dissolved pollutants. Following this reasoning, the impact of a given restoration effort, as well as the ability to detect effects, depends upon the size of the area targeted for restoration. Larger, more spatially complex areas will require greater amounts of restoration effort to achieve similar levels of recovery than can be expected within smaller areas presenting less physically and ecologically intricate challenges.

Ecological restoration: Successes and failures

Water temperature

Surface water temperature is determined by many variables, but major factors influenced by human activity include water quantity, channel morphology, subsurface exchange, and riparian vegetation (Independent Multidisciplinary Science Team, 2004; Poole and Berman, 2001). Agricultural practices potentially alter all four factors leading to increased rates of thermal alteration (warming and cooling) along stream and river networks. Restoration actions related to water quantity generally focus on reducing withdrawals from surface waters, increasing efficiency of water use, and restoring groundwater sources. Recovery of channel dimensions along streams and rivers in agricultural land commonly requires restoration of riparian plant communities, management of livestock grazing, and reversal of stream channel incision processes. Restoration of subsurface exchange, either hyporheic or groundwater, includes reconnection of hydrologic flow paths (Younus et al., 2000; Ebersole et al., 2003) or restoration of depleted alluvial sediments. Recovery of riparian shade is one of the most common agricultural restoration efforts and includes replanting, natural regeneration, livestock management, and changes in land use (Marsh et al., 2005). The hydrologic, geomorphic, and ecological processes involved in restoration actions require differing amounts of time to achieve their goals. Most require decades at the very least. None can provide immediate recovery of stream temperature and its influence on aquatic ecosystems.

Evidence of temperature response to modification of riparian vegetation in agriculturally dominated basins suggests that removal of riparian vegetation increases stream warming while reestablishment of riparian shade leads to reduced warming (Wehrly et al., 1998; Independent Multidisciplinary Science Team, 2004; Wang et al., 2003). The influence of riparian shade on rates of warming diminishes as streams become wider and discharge increases. But a few studies have noted that shade has little or no influence on stream temperature where subsurface inputs are significant (Mosley, 1983), stream water temperature is similar to air temperature (Borman and Larson, 2003), or in large streams where the relative influence of shade on surface water area is minor (Bartholow, 1995). The overwhelming number of studies of wadeable streams, however, concludes that shade influences stream temperature, thus restoration of riparian vegetation may reduce rates of warming and observed stream temperatures (Independent Multidisciplinary Science Team, 2004; Wehrly et al., 2003). Therefore, a portion of stream temperature recovery requires reestablishment of canopy cover over the stream channel. Reestablishment of channel dimensions through riparian recovery may also lead to lower stream temperatures. Reestablishment of effective vegetative canopy cover generally requires 10 to 30 years, depending upon the size of the stream and the type of riparian plant communities restored.

In northern California, late-seral riparian forests maintained summer water temperatures supporting cold-water amphibians and salmonids, while streams in grasslands exhibited higher temperatures (Welsh et al., 2005). Another study in California concluded abundance and distribution of riparian canopy substantially influenced stream temperature in basins up to approximately 75,000 hectares (158,000 acres) (Lewis et al., 2000). Deforestation in Japan resulted in loss of riparian forests and increased maximum temperatures from 22 Celsius degrees (72 Fahrenheit degrees) to 28 Celsius degrees (82 Fahrenheit degrees) during a 50-year period (Nagasaka1 and Nakamura, 1999). Fish communities in Japan were strongly affected by temperature, with more salmonids in forested reaches than found within grassland reaches (Inouel and Nakano, 2001). Studies in New Zealand observed that removal of riparian vegetation by cattle increased stream temperatures 3.9 Celsius degrees (7.8 Fahrenheit degrees) to 7.8 Celsius degrees (14 Fahrenheit degrees) and altered the macroinvertebrate community structure (Quinn et al., 1992). Investigations of livestock grazing in eastern Oregon found streams with canopy covers greater than 75 percent supported water temperatures meeting thermal requirements for rainbow trout and Chinook salmon. The lowest temperatures were observed in streams without streamside grazing (Maloney et al., 1999). Grass-dominated riparian buffers can provide as much shade as buffers dominated by woody vegetation in small Minnesota streams, but wooded buffers exhibited the lowest maximum stream temperatures (Blann et al., 2002).

Water chemistry

The Chesapeake Bay watershed represents successful coordination among various local, state, and federal agencies, as well as an instructive lesson about expectations from efforts to manage nutrient discharges from urban and agricultural landscapes. Because agriculture is the single greatest source of nutrients in the Chesapeake Bay, significant efforts were directed toward reducing nonpoint-source nutrient inputs into the watershed. Early restoration efforts focused on erosion-based best management practices (BMPs); these were relatively successful at reducing particulate phosphorus losses from agricultural land, but less successful at reducing nitrogen, which is more often transported as dissolved nitrate (Boesch et al., 2001). Most efforts were process-based, however, focusing on landowners developing and implementing nutrient management plans. Reductions in nutrient loads resulting from those plans were typically assumed rather than directly assessed through monitoring of water quality. Although ambitious water quality monitoring programs were able to describe trends at the outlets of major tributaries, it was difficult to discern the causes when restoration activities failed to meet expected objectives. Further analysis suggested increases in annual rainfall during the past decade and time lags associated with dissolved transport in groundwater have occasionally contributed to elevated inputs in surface water, despite improved nonpoint-source nutrient management, further complicating an understanding of restoration efforts (Boesch et al., 2001). Synthesis of results from restoration projects in the Chesapeake Bay watershed (Hasset et al., 2005) suggest that, although the vast majority of restoration has focused on water quality or riparian management, relatively few projects have incorporated follow-up monitoring to assess water quality and ecological benefits. Therefore, it is difficult to evaluate the success of those restorations and their effectiveness in improving water quality in the Chesapeake Bay.

Pollutants and wastes

Characteristics of soils and sediments influence time lags between implementation of management actions and improvement in water quality. If the phosphorus content of soils is high, ceasing the application of manure or fertilizer will eliminate further increases, but many crops must be grown before soil test phosphorus declines to acceptable levels (Read et al., 1973; Halvorson and Black, 1985). As long as phosphorus in soils remains high, the soil will remain a source of particulate and dissolved phosphorous for transport to surface waters. Consequently, the impact of limiting phosphorus applications may not be immediately apparent. Phosphorus can also accumulate in wetland, streambed, and lake sediments. Sediments are a recognized source of phosphorus in the overlying water column and are implicated when the phosphorus content does not decline in proportion to a reduction in inputs (Marsden, 1989). The release of phosphorus from sediments does not occur at a constant rate because of the influence of sediment type, temperature, pH, redox potential, nitrate concentration, and physical disturbance (Holdren and Armstrong, 1980; Jensen and Andersen, 1992). In addition, time lag of ecological response to a conservation measure varies in response to specific environmental conditions. In an example from Washington, Lake Sammamish failed to show an ecological response to a one-third reduction in phosphorus loading for more than 10 years before improving markedly in the subsequent five years (Welsh et al., 1986).

Similarly, soils and sediments can amass pesticides that can contaminate water and impact the ecosystem long after applications have ceased (U.S. Geological Survey, 2006). Continuing detections and impacts of DDT and its metabolites years after discontinuance of use are examples of time lag for response to intervention. Long-term existence of pesticides in stream sediments is greatest for pesticides with little affinity for water (low solubility), but pesticides with relatively high solubility and relatively fast soil degradation rates have also been observed to persist in wetland substrates (Elliott et al., 2001).

Manures applied or excreted on agricultural land contain pathogens that can be transported to surface waters and deposited into sediment (Collins et al., 2005; Muirhead et al., 2006). Although pathogens are not as likely to persist as long as some pesticides, *E. coli* have been observed to survive and even exhibit temporary growth in freshwater sediments in laboratory experiments (LaLiberte and Grimes, 1982). *Escherichia coli* have also been shown to survive for up to six weeks in stream sediments and become resuspended in the water column during storm events (Jamieson et al., 2005).

Veterinary pharmaceuticals are present in manures applied to agricultural land, as witnessed by growing numbers of reports documenting detections of antibiotics and pharmaceuticals in streams and rivers (Koplin et al., 2002; Lindsay et al., 2001) and with clear indications that at least some originate from agricultural operations (Calamari et al., 2003). It is likely that pharmaceuticals will behave similarly to pesticides, possibly remaining is sediments long after their initial introduction to surface water. Diaz-Cruz et al. (2003) reported detections of veterinary drugs in sediments, and Halling-Sorensen et al. (1998) described the presence of persistent antibiotics in sediments of fish-farm sites where antibiotics had been administered.

Given the storage capacity of sediments for nutrients and contaminants, it is unrealistic to expect management alterations that reduce inputs will have an immediate impact on water quality. Even drastic actions, such as the elimination of all pesticide applications, may not reduce concentrations to levels that can be explained by atmospheric transport until the legacy of past pesticide applications remaining in sediments are depleted. Consequently, it is important not to celebrate an apparent success prematurely because pesticides may temporarily disappear from the water column, only to reappear as they are released from sediments (Cessna and Elliott, 2004).

Some management practices have inherent time lags between establishment and their expected environmental response. For example, conservation tillage has been found to reduce soil erosion 70 percent or more in upland areas, but monitoring programs often fail to detect significant reductions in sediment loss at the watershed outlet for a decade or more. This may be the result of a temporary increase in gulley and channel erosion or large quantities of sediment already in storage at the watershed level. Until the channel system reaches a new hydraulic equilibrium with reduced sediment inflows, the sediment that once came from upland areas will be replaced by sediment from channel erosion.

Similarly, establishment of riparian buffers may disturb streambanks and have a temporary negative impact on water quality. Several years may be required for vegetation to become sufficiently established for the buffer to become effective. Conversely, the effectiveness of nutrient removal by an established buffer often declines over time as nutrients accumulate in flow paths (Sheppard et al., 2006).

Climatic effects on hydrology and water quality often have greater effects than could be expected, outweighing environmental responses from a conservation practice (Maulé et al., 2005; Glozier et al., 2006). Simultaneous monitoring of weather and water quality may allow detection of subtle changes due to management that may otherwise be undetectable. Another approach is to examine event hydrographs and only compare pre- and post-management water quality for hydrologically similar events (Glozier et al., 2006). Nonetheless, it should be expected that many years of monitoring data will usually be required to separate conclusively management effects from those affected by climatic variability.

While some ecosystem impairments take decades to recover, other watersheds may respond quickly to conservation measures. Water quality impairments caused by nonconservative contaminants, such as bacteria from human and livestock sources, which die-off or degrade quickly in the environment, have been quickly reduced in some cases. A case in point is the North Fork River total maximum daily loads (TMDL) (U.S. Environmental Protection Agency, 2004). In 1998, a bacteria (fecal coliform) impairment TMDL was developed for the 806-square-kilometer (311-square-mile) watershed in West Virginia. Both point and nonpoint bacteria sources were identified with pastureland, failing septic systems, and direct in-stream deposition via cattle defecation identified as the primary causes of bacterial impairment. The TMDL required a 36 percent load reduction from agriculture and pastureland and no reduction from other sources.

In 1998 the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), the Potomac Valley Conservation District, and the North Fork Watershed Association began work on a management plan to lessen damage from flooding and improve water quality within the watershed. In 2000, the North Fork Watershed Association obtained U.S. Environmental Protection Agency (EPA) 319 funding to implement the management plan. Implemented BMPs included fencing along streambanks, alternative livestock watering facilities, livestock water wells, riparian buffers along streams, nutrient management plans, educational programs, manure and poultry litter composting, and stream restoration. Approximately 85 percent of the farmers in the watershed were actively involved in implementing voluntary, incentive-based BMPs. The North Fork River was delisted for the fecal coliform impairment in 2004, based upon monitoring data collected from 1998-2000 showing that BMPs can effectively address water quality issues.

The effectiveness of riparian buffers, filter strips, and similar practices in reducing pollutant loadings from agricultural land has been heavily researched, but remains poorly understood, with results believed to be extremely site specific. In a review of 72 journal articles, 59 published since 2000, dealing with primary research on the effectiveness of buffers for water quality protection, buffer efficiencies were reported to be relatively high (Table 1).

Unfortunately, reported efficiencies, such as those shown in table 1, may not be representative of real-world buffer efficiencies because most experiments poorly represent field conditions and/or the long-term effectiveness of buffers. Most experimental studies have four serious limitations that constrain effectiveness in representing field conditions:

1. Most buffer research is conducted on small plots constructed so that shallow, uniform flow across the plots is maximized. In the real world, shallow, uniform flow is the exception, and most flow from upland areas crosses buffers as concentrated flow, which greatly reduces buffer effectiveness. Thus, experimental studies that do not consider concentrated flow effects tend to overestimate buffer effectiveness.
2. Most buffer research is conducted on small plots with small source-area-to-buffer-area ratios that are not representative of buffers installed under actual field conditions. For example, across the 69 studies analyzed in table 1, the source-to-buffer area ratio ranged from 0.4:1 to 55:1, with a median of 5.5:1. This median value would require the conversion of 18 percent of agricultural land to buffers and is considerably higher (two to three

Table 1. Reported effectiveness of riparian buffers for reducing nonpoint-source pollutants (runoff, sediment, nutrients, and pesticides).

	Reduction		
Parameter	**Range (%)**	**Mean (%)**	**n**
Runoff	21 to 88	51	8
Biological oxygen demand	18	18	1
Ammonium	28 to 87	65	9
Nitrate (runoff)	9 to 99	69	13
Nitrate (subsurface)	49 to 91	72	6
Phosphate	36 to 98	73	8
Total Kjeldahl nitrogen	11 to 79	48	5
Total nitrogen	37 to 94	64	11
Total phosphorus	5 to 91	61	18
Sediment	17 to 100	84	69
Atrazine	22 to 70	51	6
Metolachlor	51 to 66	56	3
Fecal coliform	28 to 90	67	4

times) than the recommended, or allowed, ratio in most buffer programs.

3. Most experimental buffer studies are conducted on newly established buffers (typically less than a year since establishment), with most monitoring lasting for less than a month. Thus, most experimental buffer study results represent effectiveness only during establishment, failing to furnish estimates of long-term effectiveness.
4. Most experimental buffer studies on cropland either use or simulate conventional tillage and agrochemical applications in the experimental area. This is unrealistic. Buffers should only be used in concert with in-field systems of conservation practices designed to keep sediment and agricultural chemicals in the field where they are valuable resources rather than pollutants that need to be trapped by buffers (Dillaha et al., 1989). The few buffer experiments simulating high sediment and nutrient loadings over longer time periods suggest the effectiveness of overloaded buffers will decline dramatically over time.

Only one of the studies summarized in table 1 (Udawatta et al., 2002) simulated real world conditions in terms of concentrated flow patterns, reasonable source-to-buffer-area ratio, and use of infield conservation practices (no-till) in addition to buffers. This three-year study used a paired approach, with a control watershed in row crops [1.6 hectares (4 acres)] and two treatment watersheds: One with grass buffer strips [3.2 hectares (7.9 acres)] and the other with trees in grass buffer strips [4.5 hectares (11 acres)]. No-till was used on cropland in all three watersheds. Grass buffers and trees in the agroforestry treatment were established in 1997, with monitoring initiated at the same time. The buffers consisted of a system of in-field contour buffers and grass waterways along major in-field drainageways. The cropland-to-buffer-area ratio was approximately 8:1, with about 13 percent of the treatment watershed area devoted to buffers. Runoff, sediment, and nutrient losses were monitored at watershed outlets. The control watershed had total phosphorus, total nitrogen, and nitrate losses of 0.42, 1.52, and 0.28 kilograms per hectare per year (0.92, 3.36, and 0.63 pounds per acre per year), respectively, indicating no-till was effective in minimizing nutrient losses without buffers. The grass buffer and agroforestry treatments reduced surface runoff

10 percent and 1 percent, respectively; sediment losses increased 35 percent and 17 percent, respectively; total phosphorus losses declined 8 percent and 17 percent, respectively; total nitrogen losses declined 14 percent and 11 percent, respectively; and nitrate losses declined 21 percent and 5 percent, respectively. The reported increases in sediment losses with the buffers were unexpected, but the losses with the source areas in no-till were so low that the increase was negligible. Sediment losses from the control, grass buffer, and agroforestry treatments were 27, 33, and 36 kilograms per hectare per year (60, 72, and 79 pounds per acre per year) over the three-year study, which is extremely low and indicative of excellent no-till production.

Aquatic communities

The extent of actions intended to improve aquatic habitats in agricultural landscapes varies across the United States and Canada because agricultural land is generally privately owned and management objectives may not include concern for fish and wildlife habitats. While U.S. Department of Agriculture (USDA) farm bill programs offer increasingly attractive financial incentives for conservation of aquatic resources, the degree to which restorative actions are implemented and monitored for effectiveness is challenging to evaluate and report. This is apparent by the poor rate at which restoration projects have been evaluated (Bernhardt et al., 2005a). This lack of evaluation is a consequence of limited dollars allocated for monitoring and a failure by those who formulate conservation policies to recognize the importance of long-term monitoring to refine performance of conservation programs and practices. Monitoring designs are necessarily intricate and expensive to implement because of the ecologically complex nature of stream, river, floodplain, and upland processes. Nevertheless, monitoring is essential to determine what works and does not work under different circumstances and to gain knowledge on how long it takes for conservation practices to become effective. In a blue ribbon panel's review of USDA's Conservation Effects Assessment Project (CEAP) (Soil and Water Conservation Society, 2006), panel members concluded that lack of resources for monitoring was a significant limitation of CEAP and other conservation programs. They concluded: "The most important and troubling missing piece is the absence of plans for on-the-ground monitoring of change in the environmental indicators and outcomes conservation programs and activities are intended to improve." The panel recommended that Congress mandate that at least one percent of the funding for each authorized program—about $40 million of the $4 billion U.S. taxpayers are investing in conservation— be set aside to support monitoring and evaluation of those programs.

Restoration actions targeted to improve habitats for aquatic species are difficult to evaluate because effects can be influenced by physical, biological, and chemical responses at multiple spatial and temporal scales having variable affects on biological communities (Minns et al., 1996; Lammert and Allan, 1999; Fitzpatrick et al., 2001; Vondracek et al., 2005). Moreover, suites of practices installed either sporadically or strategically in a catchment will differentially influence the breadth and timing of response of stream or wetland species and their physical habitats. Thus, correlations between a specific practice and the ecological response of an organism or its habitat are not easily discerned. These limitations aside, recent studies focusing on effects of agricultural practices on conservation of aquatic species and their habitats are beginning to offer insights into which practices may be effective at arresting declines in North American aquatic species. In most cases, management practices that retain or improve connections among ecological processes and/or different aquatic habitats contribute to the quality of those habitats and the well-being of the aquatic species that inhabit them.

Along stream and river corridors, fish, amphibians, and aquatic insects move among different habitat types, including pools, riffles, backwaters, wetlands, sloughs, alcoves, hyporheic zones, and riparian zones during their life cycles. Agricultural practices can be modified to maintain connections between essential components of habitat across space and time. In 20 streams in agricultural land within the Minnesota River Basin, wooded riparian areas supported higher fish richness, diversity, indices of biotic integrity, and macroinvertebrate communities than recorded within nonwooded, open reaches (Stauffer et al., 2000). Restoration practices that effectively reconnect upstream and downstream aquatic habitats include providing fish passage around or through barriers, such as dams or poorly constructed culverts (Pess et al., 1998; Hart et al., 2002; Johnson, 2002). Breaching dikes potentially reconnects riverine migration routes with estuarine rearing and holding habitats (Frenkel and Morlan, 1991). Installation and active management of water control structures in constructed or restored wetlands have been effective in preventing entrapment, allowing fish to emigrate out of floodplain wetlands entered during seasonal high flows (Swales and Levings, 1989, Thomson et al., 2005; Henning, 2005).

Keeping fish and water in streams and out of irrigation ditches increasingly is an objective of ranchers and farmers in the arid west, triggering installation of sophisticated fish screens for irrigation diversions (McMichael et al., 2004) and effective irrigation conservation management techniques through candidate conservation agreements [David Smith, USDA-NRCS, personal communication: (http://www.mt.nrcs.usda.gov/about/mtstcm/feb05/grayling.html).]

Simply maintaining physical connectivity between intermittent stream channels used as drainage ditches and mainstem rivers has been shown to influence the amount of winter habitat for native fish, benthic invertebrates, and amphibian species in the grass seed farms of the Willamette Valley of Oregon (Colvin, 2005). Similarly, maintaining open drains on agricultural land in Ontario provides habitat for fish assemblages identical to those inhabiting nearby streams (Stammler, 2005).

Connecting habitats includes maintaining ecological linkages between riparian zones and streams. For example, riparian vegetation structure influences the composition and abundance of terrestrial insect communities. By altering grazing management regimes to favor persistence of riparian vegetation where terrestrial insects thrive, fish benefit from seasonally important food sources. Grazing systems that allow cattle to graze for short durations increase terrestrial insect production, which has been shown to correlate strongly with fish condition and survival on Wyoming ranchland (Saunders, 2006; Saunders and Fausch, 2006).

Loss of cropland due to streambank erosion has elevated interest in riparian management that includes replanting of herbaceous and woody riparian buffers, often coupled with instream rock or wood to deflect the flow away from unprotected banks. Preliminary investigations in western Oregon indicate such streambank stabilization practices, if designed correctly, encourage instream processes important to aquatic species, including retention of detritus and large wood for fish cover and macroinvertebrate food sources (Stan Gregory, unpublished data). Studies in Minnesota further support the importance of riparian corridor conservation and restoration to aquatic species because it contributes to instream habitat and geomorphic features at multiple scales (Stauffer et al., 2000; Blann et al., 2002; Talmage et al., 2002).

Instream structural improvements have improved fish habitats at some sites. Assessment of the effectiveness of instream structures placed in western Washington and Oregon streams over the last three decades revealed that the majority of sites exhibited significantly higher densities of juvenile coho salmon, steelhead, and cutthroat trout after restoration (Roni and Quinn, 2001). While placement of instream log structures has proven valuable in the Northwest, failures in the effectiveness of this practice in the southeastern United States indicate re-introduction of large wood to drastically altered stream systems is often unsuccessful when placed in stream reaches physically unable to retain them (Shields et al., 2006).

Terrestrial wildlife

The purpose of USDA conservation programs is not to restore native ecosystems but to lessen undesirable environmental effects of agricultural production. Yet these policies, at times imperfect, have brought about significant improvement in the quality and distribution of wildlife habitats associated with agricultural land across much of the American landscape. Fundamental to the design of successful conservation and agricultural policies is recognition that farming and environmental quality improvements are not mutually exclusive goals, nor are environmental solutions associated with soil erosion, water quality, and wildlife habitats independent issues.

Established in 1986, embedded within all 50 states, and composed of an eclectic mix of conservation practices, the 14.6-million-hectare (36-million-acre-plus) CRP represents a cornerstone of USDA conservation policy. Investigations describing the environmental, social, and economic effects of CRP offer insight on at least some effects of conservation policies on wildlife and their habitats (Allen and Vandever, 2005; Haufler, 2005). Some benefits have been profound, such as 25 million ducks produced in the Prairie Pothole region due to the nesting cover provided by CRP grassland. Other benefits are more understated—doubling of the range of mule deer across the Texas Panhandle, for example, or the reversal in population declines of various songbird species in response to CRP grassland replacing crops on highly erodible land. Many CRP conservation practices (e.g., planting of native and introduced grasses, field borders, riparian buffers) are implemented in other federal and state conservation programs. It seems reasonable to assume wildlife-related effects described for individual CRP conservation practices have similar benefits and consequences when applied as part of these other programs as well.

Economic and social support for rural communities, aesthetically pleasing landscapes, recreational opportunities, and sustainable populations of wildlife represent ecosystem services delivered from agricultural land use whose importance is not often adequately captured in assessments (Feather et al., 1999; Costanza et al., 2000). Although wide-ranging personal and social effects of the CRP remain impractical to measure, these nonquantifiable benefits are valued particularly by those most directly affected. CRP participants attribute improving future productivity of land, retention of water from rain and snow, reappearance of springs, improved quality of well water, prevention of unwanted urban expansion, stability in income, lower operational costs, and control of drifting snow as program benefits (Johnson and Maxwell, 2001; Bangsund et al., 2002; Allen and Vandever, 2003). For many, the CRP has enhanced aesthetic qualities of their farmland, brought greater numbers of wildlife, and increased opportunities for recreational and social use of their land. Many of these benefits were delivered soon after establishment of conservation practices, but an accurate assessment of their economic and social significance remains elusive.

For the sake of simplicity, visualize most wildlife inhabiting agriculturally dominated regions as belonging in one of two groups. Farmland wildlife (e.g., ring-necked pheasant, bobwhite quail, white-tailed deer) generally prosper where a relatively small proportion (e.g., less than 10 percent) of the landscape is dedicated to nonfarmed vegetation, with crop production remaining the prevailing land use. The other category can be characterized as wildlife endemic to grassland (e.g., upland nesting waterfowl, prairie chickens, and pronghorn antelope). These species are generally dependent upon relatively large, contiguous blocks of grassland cover. Farmland species benefit from high levels of interspersion between farmed and nonfarmed land uses; most wildlife species endemic to grassland ecosystems do not.

Conservation programs administered by USDA have benefited species whose elemental habitat requirements are met by conservation practices designed to most appropriately address regionally prevalent forces of soil erosion. In drier, western regions, whole fields planted to grasses offer the greatest opportunities to address wind erosion and the needs of grassland wildlife. In wetter climates, where soil erosion by water is an issue of greater concern, grass filter strips, riparian buffers, field borders, and removal of smaller tracts of erodible land from cultivation typically enhance habitat quality for farmland wildlife adapted to higher levels of interspersion between land uses.

Time lags in ecological responses

Restoration practices inherently require variable periods of time for ecological processes to deliver desired outcomes, for systems to adjust to restoration measures, for invasive species to be reduced, for desirable endemic species to increase, for toxicants and other forms of degradation to be eliminated or isolated in long-term storage, and for connections between habitats, communities, and ecosystems to be restored (Harding et al., 1998; Sarr, 2002; Bond and Lake, 2003). Wetland restoration studies in the southeastern United States found recovery of amphibian communities was affected by drought and disease after seven breeding seasons, leading to the conclusion that long timeframes are necessary for monitoring programs to assess accurately the outcomes of restoration practices (Petranka et al., 2003). Time lags in replanted vegetation reaching maturity were identified as one of the most serious limitations of restoration for birds and arboreal mammals in Australian agricultural landscapes (Vesk and MacNally, 2006). Monitoring vegetative characteristics of CRP grassland in the Great Plains over a 12-year period, Cade et al. (2004) found that vegetative variables affecting the quality of wildlife habitats varied not only by grass species planted, but also through time and in response to natural or human-induced disturbance. Harding et al. (1998) concluded that the best predictors of present macroinvertebrate communities in streams of the southeastern United States were land use and land cover conditions in the 1950s. The influences of past agricultural land uses on invertebrate communities were still evident after more than 45 years, even though the local riparian areas had become reforested. As Bond and Lake (2003) noted, "…legacies of past disturbances and the impacts of on-going disturbances operating at larger (possibly catchment-wide) scales can compromise works done at individual sites or reaches."

Temperature

Restoration of thermal regimes in stream networks is dependent upon processes that influence shade, discharge, channel dimension, and hyporheic exchange. Restoration of riparian shade clearly requires many years for an adequate, contiguous vegetative canopy to develop along a reach. Geomorphic processes may require decades to adjust channel dimensions, and reconnection of hydrologic flow paths for subsurface exchange are functions of channel structure and hydrologic regimes. A New Zealand study compared physical and biological characteristics of nine riparian buffers, replanted and fenced between 2 and 24 years, with conditions found within control reaches (Parkyn et al., 2003). Some stream properties, such as water clarity and channel stability within treated reaches, responded rapidly. Other characteristics, such as nutrient concentrations and presence of fecal coliform bacteria, were highly variable. Macroinvertebrate community composition did not respond within the time period investigated, which was attributed to the lack of response in stream temperature. Stream temperature could not be expected to adjust until canopy cover by riparian vegetation had recovered (Quinn et al., 1992).

Past or future changes in hydrologic connections can affect the location and timing of thermal responses to restoration. Roads, ditches, and diversions can also influence stream temperatures by changing the routing of surface and subsurface flows, which may be warmer or cooler than the stream temperature (Story et al., 2003). Consequently, stream temperatures may not respond to recovery of riparian vegetation if the routing of water from ditches or drains significantly alters stream temperatures. Also, restoration of hydrologic connectivity and detention through recovery of hyporheic zones through channel aggradation or reestablishment of wetlands may require several years or decades for hydrologic paths to become reestablished and well integrated into the flow network.

Nutrients and contaminants

Groundwater nitrate, leached from surface soils via subsurface flow to near-stream zones, may be an important source of nitrogen to surface waters (Cirmo and McDonnell, 1997). In some river systems, groundwater can make up as much as 50 percent of river flow, and groundwater may be decades to centuries older than surface water (Michel, 1992). In such systems the potential for time lags in water delivery can have a profound impact on the ability to detect degraded systems and quantitatively describe responses to restoration. For example, if recent land use practices lead to eutrophication of surface waters, it is possible for dilution by older and deeper flow systems with higher quality water to mitigate observed water quality degradation, particularly during baseflow conditions. On the other hand, shallow groundwater can retain nitrate concentrations for 40 years or more in the absence of reducing sediments (Bohlke and Denver, 1995). In these systems, detecting positive effects in post-restoration monitoring can be hampered by delivery of enriched, pre-restoration water to the stream. In such flow systems, however, long time lags reflect slow rates of delivery; hence, the ability of deeper flow systems to influence instantaneous stream concentrations would require substantial groundwater sourcing. Thus, although the full benefits of restoration practices may be masked in some systems by lags imposed on nitrogen-enriched groundwater, significant masking after a decade should be unusual.

In Mid-Atlantic States, nitrogen leaching from tributary watersheds of the Chesapeake Bay has increased since 1985 despite widespread restoration activity (Lindsey et al., 2003). Although patterns of individual watershed discharges vary, there is no clear trend across the basin (Alexander and Smith, 2006), leading to concerns about the effectiveness of nearly 20 years of restoration efforts under Chesapeake Bay agreements (Boesch et al., 2001). One recent study showed that although base flow is made up of water between 1 and 50 years old most water in the Chesapeake Bay watershed enters streams within a decade (Lindsey et al., 2003). Although the proportion of baseflow in streams can be influenced by the quantity of annual precipitation, average residence times for groundwater range from 10 to 20 years (Michel, 1992; Focazio et al., 1997). A comparable range of 2 to 9 years has been observed for nitrogen concentrations in waters at the Mississippi River outlet (McIssac et al., 2001), as well as 5 to 10 years for large rivers in Latvia (Stalnacke et al., 2003).

The time lag in nitrogen recovery introduced through soil percolation and groundwater contribution to surface water is relatively short compared to the lag expected in phosphorus recovery due to percolation pathways (Oenema and Roest, 1998). In soils with low phosphorus sorption capacities, unsustainable additions lead to soil saturation, and thereafter phosphorus concentrations in groundwater will increase with the degree of phosphorus saturation. Under these conditions, conservation actions that act to reduce or eliminate phosphorus application surpluses will have no immediate impact on phosphorus reaching surface waters by the percolation pathway. Model estimates suggest phosphorus transport through surface pathways may respond within 5 to 50 years, but phosphorus moving by the percolation pathway may take centuries to respond to management changes (Schippers et al., 2006).

Besides limiting observed benefits of restoration, knowledge of subsurface flow pathways can increase understanding about effectiveness of restoration activities. Molenat and Gascuel-Odoux (2002) showed that reduced nitrogen leaching along a 500-meter (547-yard) field-to-stream transect with three distinct flow pathways lowered recharge nitrogen concentrations from 100 to 80 milligrams per liter (100 to 80 parts per million) while simulated stream concentrations declined from 57.4 to 45.9 milligrams per liter. Water lag times in this study ranged from less than one year to three years. By redistributing patterns of nitrogen leaching to take advantage of longer travel times and denitrification from pyrite-rich subsurface sediment layers, the authors achieved similar reductions in simulated stream concentrations without changing average groundwater loadings. Thus, in addition to clarifying understanding about the timing of restoration effects, knowledge of groundwater flow pathways can be used as a mitigation or restoration tool to help reduce stream nutrient concentrations (Lindsey at al., 2003).

The Walnut Creek monitoring project in central Iowa investigated response of stream nitrate concentrations to changing land use patterns in a 5,218-hectare (12,894-acre) agricultural watershed over 10 years (Schilling and Spooner, 2006). In 1990, soybeans and corn constituted 69 percent of land use in the Walnut Creek watershed. Between 1990 and 2005, land devoted to row crops declined from 69 percent to 54 percent of the watershed area as a consequence of a U.S. Fish and Wildlife Service prairie restoration project. As a result of the land use changes and implementation of nutrient management programs between 1995 and 2005, nitrogen applications in the watershed declined 21 percent. Nitrate concentrations, however, still exceeded the standard of 10 milligrams of nitrate-nitrogen per liter for drinking water, with concentrations highest in the spring and early summer. Over the 10-year monitoring period, trend analysis indicated nitrate concentrations declined by about 0.12 milligrams per liter per year, or a total of 1.2 milligrams per liter for the whole basin, and by 8 to 12 milligrams per liter in smaller subbasins if a control watershed was used as a covariate. Without adjusting for the control, the reduction was 0.07 milligram per liter per year for the overall basin. Schilling and Spooner (2006) had estimated that a 10 percent change in row-crop area was required for a 1.95-milligrams-per-liter change in nitrate levels over a 10-year period. The lag time between reduced applications of nitrogen fertilizer and nitrate levels in Walnut Creek was influenced by the mean residence time for groundwater, which was estimated to be 14 years. Consequently, Schilling and Spooner (2006) concluded that it was impractical to detect changes in nitrate water quality in larger watersheds in less than several decades, and documentation of improvements in water quality due to conservation practices should focus on small subbasins where changes can be detected in shorter time frames.

Another mechanism influencing efficiency of denitrification in riparian areas is hydrologic connection between enriched groundwater and biogeochemically active sediments (Hill, 1996). Results from investigations in a series of European riparian areas suggested differences as small as 20 to 30 centimeters (8 to 12 inches) in water table depth had a significant effect on denitrification rates (Hefting et al., 2004). Channel incision and/or ditching to improve field drainage are common in agricultural land use, though sometimes incision is an unintended consequence of increasing channel flows. Such hydrologic modification can result in disconnection between enriched groundwater and denitrifying soil layers. Thus, restoration success can be hampered both by changes in hydrologic routing that reduce exposure of nitrogen-enriched waters to denitrifying sediments and alteration of the redox conditions required for denitrification (Pinay et al., 2002). Across whole watersheds, lack of hydrologic connection between nutrient sources and streams can lead to poorly buffered systems, even when a substantial portion of near-stream zones are forested (Weller et al., 1998; Baker et al., 2006).

Aquatic communities

The challenges of detecting and describing ecological successes or failures in improving conditions for aquatic species are due to multiple factors, not the least of which is the inherent variability in life-history patterns of aquatic species. Because fish assemblages are variable from day to day, month to month, year to year, and longer periods, data collected at randomly selected sites to determine if fish are responding to habitat improvements are difficult to interpret (Adams et al., 2004). This challenge may, however, be less daunting than the conflict between time lags in responses of species, habitats, and landscapes and the essentially nonecological timeframes of human systems. Farm policy, political administrations, landowner dynamics, and agency personnel change many times before watersheds can demonstrate recovery. Legislators want proof that restoration actions are worth the money invested, yet scientists provide only scant amounts of data that often cannot unequivocally prove success in the timeframe demanded by those who formulate or fund legislation affecting conservation policies. Failure to recognize complexities of natural and managed systems, recognition of time lags after implementation of conservation practices, and the historical lack of funding in support of long-term monitoring programs are underlying causes limiting the ability of science to answer fundamental questions about effectiveness of conservation practices and policies on aquatic species. Dynamic systems, such as rivers and streams, change constantly in response to natural disturbances and human perturbations. Conservation policymakers need to recognize change is not only normal in ecological systems, but confounding. Existing environmental issues and unanticipated effects of land use have occurred over decades and centuries. In most cases, it is unreasonable to expect that conservation or restoration will have immediate and permanent benefits to aquatic species and their habitats.

On the other hand, it is quite reasonable to assume that changes in land use practices in uplands will influence the habitats of aquatic species because aquatic systems are a reflection of environmental conditions in a watershed. Conservation tillage, residue management, and conservation buffers that improve overall surface water quality will, over time, benefit the species that use surface waters as habitats. Similarly, where clear, cold water exists, coldwater species can likely exist. Thus, conditions that influence temporal changes in stream temperature (as described previously) also influence temporal species responses. Conservation practices, such as riparian buffers designed to provide shade and channel features that maintain coolwater refuges, will over time provide habitat for species in search of such habitats, assuming a population source exists and barriers do not restrain immigration to those habitats. Some restoration measures do result in an immediate response by fish. Studies in the Pacific Northwest demonstrate success in reconnecting migratory routes and their habitats for anadromous salmonids (Beamer et al. 1998) and providing cover (Roni and Quinn, 2001). Kanehl et al. (1997) evaluated removal of a low-head dam and determined that both stream habitat and desired fish assemblage improved within five years.

Terrestrial wildlife

Effects of conservation polices on wildlife may be seen in a relatively short period of time or may take years to yield observable results. Removal of environmentally sensitive land from crop production has brought observable and immediate benefits to some species, but effects of alternative production and conservation practices, such as minimum tillage and terraces, are not always obvious or quantifiable. The cumulative effects of these practices, however, contribute to improvements in the quality of aquatic habitats downstream from the fields where the practices are applied.

A majority of investigations describing CRP effects on wildlife and their habitats have been completed on the scale of individual fields or by conservation practice (e.g., riparian buffers). The presence of conservation features in isolation, however, rarely has a definitive influence on abundance and distribution of many wildlife species. Rather, overall land use, cropping practices, and the spatial configuration of conservation practices with land remaining in production define long-term capabilities of agriculturally dominated landscapes to support viable populations of wildlife (Rodgers, 1999; Krapu et al., 2004; Taylor et al., 2006). Specifically linking quantitative responses of wildlife with conservation practices depends upon the species in question and becomes complex because wildlife species respond differently as vegetative characteristics change through time and in response to application, or absence, of disturbance brought on by tillage, fire, grazing, or other management practices (McCoy et al., 2001; Fritcher et al., 2004; Cade et al., 2005). Individual conservation practices may be beneficial for one species, but have negative effects on the suitability of habitat for others. For example, in the Texas panhandle, mule deer have expanded their range into heavily farmed landscapes as a consequence of the cover provided by introduced species of grass under the CRP. The same conservation practice, however, has concurrently diminished availability of habitat for swift fox because the vegetation becomes too tall and unsuitable for the animal's use (Kamler et al., 2001; Kamler et al., 2003).

During the past two decades, there have been many outstanding studies on how wildlife responds to the inclusion of conservation practices in intensively farmed landscapes. These investigations have been, and continue to be, used to refine USDA conservation policies and management guidelines. Hard numbers or measures are needed through which progress toward specific goals can be measured. Wildlife management in agricultural landscapes is well described; however, it is difficult to predict how numbers or distributions of wildlife will change in response to conservation practices. The one overarching criticism that might be directed toward research into wildlife response to conservation policies within agricultural ecosystems is a lack of focus on specific species, making identification of precise, quantifiable goals difficult. If specific goals cannot be identified for unique areas (e.g., farm, watershed, region) it is impossible to furnish measures that accurately describe progress toward reaching those goals.

Wildlife response to contemporary conservation policies in agricultural landscapes is potentially diverse, but it is not possible to optimize management for all species. There are wildlife species whose abundance and distribution reflect a practical balance between conservation and economically viable agriculture. Across much of the Great Plains and Corn Belt, for example, the ring-necked pheasant is perceived as a symbol of balance between agricultural production, conservation, and social value. The same circumstance is represented by upland-nesting waterfowl in the northern Great Plains, across the Southeast by the bobwhite quail, and by anadromous fisheries and sage grouse in the Northwest. Grassland birds in the Northeast are also species that can stand as emblems of balance between agriculture and conservation. These are generally the species about whose habitat needs the most is known. If habitat for these species is furnished, the needs for many, not all, other wildlife species inhabiting agriculturally dominated landscapes will be provided. It is the known habitat needs of these species defined at the field, farm, and watershed levels that offer greatest potential to define beneficial management practices and measurable goals through which the effectiveness of conservation can be more precisely described.

Acceptance of conservation goals affecting wildlife habitat and environmental quality in agricultural landscapes presents social as well as scientific challenges. Conservation programs have been an important source of income for small, intermediate, and rural-residence landowners who are less likely to adopt practices requiring substantial economic investment, technical skills, or management-intensive alternatives (Lambert et al., 2006). Larger operators, whose primary occupation is farming, are more likely to dedicate a smaller percentage of their land to conservation, but they are more likely to install practices generally requiring higher costs and compatibility with sustainable production of crops. The desires and limitations of landowners with differing personal and economic goals must be a part of any successful effort to enhance wildlife habitats associated with agricultural land use over the long-term.

Measuring cumulative effects

In many ways, "cumulative effects" is a vague concept applied to complex interactions. Rigorous scientific assessment of cumulative effects most commonly addresses coupled processes that lead to complex outcomes, but often does not fully address the full range of collective effects. In many ways, the spatial, temporal, and social complexity of landscape-level cumulative effects far exceeds the capacity of most environmental measurement and analysis systems. Yet management of simple sets of processes or small numbers of target species often leads to overly simplistic conclusions and adoption of practices that may degrade other resources. Analyses of multiple factors and processes along river networks has provided important frameworks for restoration of stream ecosystems and associated riparian areas (Li et al., 1994; Gore and Shields 1995) that may be applicable for evaluation of other conservation and restoration practices within agriculturally dominated landscapes.

Cumulative effects of riparian buffers and nutrient responses

Although much effort has been focused on the benefit of riparian buffers and restoration at local sites, comparatively little work has addressed cumulative downstream impacts on water quality (Dosskey, 2001). Recent advances in use of stable isotopes seem promising (e.g., Bohlke et al., 2004), but few tools exist to distinguish permanent from temporary nitrogen sinks across whole watersheds and signal a definitive response to restoration. Because most agricultural land use patterns reflect aggregate land use decisions by individual landowners and most watercourses within watersheds are not well-buffered, it is difficult to detect and measure effects of restoration activities. Baker et al. (in press) recently studied land-cover patterns in more than 500 watersheds from four physiographic provinces within the Chesapeake Bay watershed. The authors compared watershed cropland proportions with proportions adjusted downward to represent presumed effects of existing riparian forests and wetlands. In this manner, they sought to examine whether extant patterns of riparian buffers were likely to result in reduced nutrient discharges compared to those expected from unbuffered areas. Results of the investigation led the authors to conclude that even when riparian buffers were assumed to reduce nutrient concentrations as effectively as in published studies (e.g., Lowrance et al., 1997) most watersheds showed buffer patterns that would not lead to a substantial reduction in nutrient discharges. This finding underscores the need for widespread changes in land use practices that include establishment of riparian buffers as well as the importance of multiple strategies for reducing nutrient exports.

Most studies of riparian buffers demonstrate water quality benefits measured along field-to-stream transects (e.g., Peterjohn and Correll 1984; Lowrance et al., 1997) or describe substantial denitrification potential (e.g., Groffman et al., 2002; Addy et al., 2002). By implementing buffer restoration, many managers assume the costs of restoration will be offset by the benefits described in the scientific literature. Prevailing evidence in the form of spatial and temporal variation in buffer effectiveness suggests, however, that the water quality benefits of any buffer restoration are likely to be conditional rather than universal (e.g., Jordan et al., 1993; Hill, 1996; Correll et al., 1997; Vidon and Hill, 2004; Hefting et al., 2004). There may be a wide range of water quality benefits achieved by placing restoration activities at specific locations (e.g., Dosskey et al., 2005), but at present, there is little coordination of restoration efforts (Bernhardt et al., 2005a; Palmer et al., 2005). Given such uncertainties, it seems unlikely multiple restoration projects will necessarily provide consistent, additive water quality benefits across space or through time. This is an operating assumption yet to be evaluated across an entire watershed, however. Even so, it remains unclear whether the benefits of riparian system restoration result from nutrient interception (Lowrance et al., 1997; Weller et al., 1998), improving stream uptake potential via restoration of stream functionality (Peterson et al., 2001; Bernhardt et al., 2005b), reducing pollutant loadings by removing land from production (Dosskey, 2001), or some combination of these alternatives focused on the needs within specific landscapes. Understanding the spatial effects of these management alternatives and their potential benefits should allow greater definition of coordinated monitoring strategies and more effective prioritization of restoration spending.

Cumulative effects of economics, policy, land ownership, and ecological recovery

Complex interactions between land uses, economics, policies, and ecological processes strongly influence the timing of physical, chemical, and biological responses to conservation practices. Land use patterns reflect aggregate outcomes of rational decisions by individual landowners to optimize returns from their agricultural resources, but discrete priorities by landowners rarely result in ecologically well-integrated watersheds. Political policies affect land use change more rapidly (2 to 20 years) than the ecological processes (10 to 100 or more years) we are trying to conserve or restore. As a result, most agricultural landscapes exhibit spatial patterns of land cover and aquatic and terrestrial communities that primarily reflect the "footprint" of impermanent policies and short-term economic decisions.

Landowners, communities, and resource managers are always faced with choices of actions that sustain, deplete, or rebuild existing resources (Pitcher, 2001). Industries and societies that harvest or extract natural resources often observe gradual, long-term depletion of environmental assets. Pitcher (2001) identified three major tendencies of fisheries harvest that tend to cause a "ratcheting effect" leading to resource depletion. The first depletion effect, which he termed "Odum's ratchet," is the tendency for past ecological conditions to become harder to restore when species (or genotypes) become extinct. As we lose biological components, ecological functions are more likely to be irreversibly changed.

The second depletion effect, termed ''Pauly's ratchet,'' is based on the tendency for each of us to relate changes in our ecosystems to what those systems were like when we began our careers. "Accounts of former great abundance are discounted as anecdotal, methodologically naive, or are simply forgotten" [Pauly (1995), as quoted in Pitcher 2001].

The third depletion effect, termed ''Ludwig's ratchet,'' is the tendency to increase harvest capacity through financial investment that requires continued amounts of declining resources to be harvested, generating further investment in technological capacity to harvest more resources.

Agricultural parallels are obvious, such as increased crop productivity leading to soil, water, and nutrient depletion, which requires loans for more specialized equipment and agrochemicals, which requires sustained production to repay loans required for their purchase, resulting in increased harvests from systems where soil and water resources are already becoming increasingly limited. Just as ocean fisheries have witnessed serial depletions within and among species caused by overharvest as a consequence of technological advancements in the fisheries industry, agriculture has experienced shifts in crop types and land uses as agronomic capacity becomes altered and required resources become scarce (Potter, 1998; Cochrane, 2003).

In light of the dual nature of conservation and restoration, an additional ratchet effect—"the restoration ratchet," can be added to those defined by Pitcher. This ratchet mechanism reflects the tendency to view conservation and restoration as immediately and fully effective, thereby offsetting choices leading to more intensive land use, further depleting remaining resources. In reality, the outcome of restoration may not be realized for decades after it is first implemented, and the success of conservation of existing resources remains largely unproven. This inherent tendency to assume efforts to restore depleted resources immediately counterbalance actions that deplete resources inevitably leads to continued decline in natural resources as well as ecosystem structure and function.

Achieving greater conservation effectiveness at landscape or watershed scales

Timeframes for responses to restoration actions

Realistic timeframes for responses to ecological restoration in agricultural landscapes can be rapid (1 to 5 years), relatively fast (5 to 20 years), intermediate (20 to 50 years), slow (50 to 100 years), or extremely slow (greater than 100 years). Why do ecological processes and ecosystem components exhibit such widely differing rates of responses to restoration efforts? Many factors contribute to the timing of responses of different landscape structures, populations, and communities. Agricultural landscapes contain complex physical landforms, chemical environments, biotic communities, human communities, and histories of change. The characteristics of all of those fundamental features of agricultural land vary enormously from location to location. Therefore, it is impossible to identify exact timeframes for ecological responses to restoration efforts. We summarize several factors that shaped the responses observed in the examples we presented in Table 2.

The landscape and its physical processes set limits on potential rates of recovery in terrestrial and aquatic systems. For example, many river channels throughout the United States have been simplified and straightened. Restoration of river channels requires reconnecting historical side channels and floodplains, reestablishing channels where they have been eliminated, and restoring natural flow regimes to the extent possible. The rate of recovery of those channels will depend upon the occurrence of natural flood processes that shape and maintain river channels and their floodplains. Timing of such restorative floods will depend upon the chances of their occurrence and future weather patterns.

Rates of ecological recovery also depend upon the degree to which the system has been altered. Obviously, a slightly altered system is likely to recover much more rapidly than a landscape that has been greatly changed. For example, a farmland with large patches of native forests and relatively well connected riparian forests will respond rapidly to restoration efforts that reconnect the fragmented pieces. In contrast, a farmland that is almost completely converted to cropland, with little or no remnant native forests, will require 50 to 100 years or more to begin to support native terrestrial and aquatic communities endemic to native forests.

Recovery of ecosystems depends upon the availability of species and the resources they require. As a result, the legacy of past systems can influence recovery. For example, old-growth forests develop diverse microbial communities and organic matter in their soils. In the decades following harvest of old-growth forests, the soils contain organic matter, microbes, seeds, and invertebrates from the old forest. After repeated harvest cycles, organic matter becomes depleted, microbial diversity declines, and invertebrate communities shift to those adapted to earlier stages of forest succession.

Legacies are also important in terms of contaminants and nutrients applied and accumulated over time in agricultural landscapes. Legacies of contaminants can cause recovery to be extremely slow. Contaminants that breakdown slowly and are strongly attached to soils and particles may reside in agricultural soils for decades after agricultural practices change. The long-term trend in the persistence of DDT is an example. DDT breaks down to other chlorinated forms of hydrocarbons in 5 to 10 years, but the other forms (DDD and DDE) commonly are found in soils, organisms, and water for 30 years or more. Some chemicals, such as heavy metals like mercury and arsenic, can bind to soils and remain in storage for centuries.

Rates of ecological processes create limits for recovery. One obvious example is riparian shade. When restoration programs plant native trees along streams to restore shade, it is obvious that seedlings will provide little shade. Several decades (20 to 50 years, depending upon species) may be required to develop full canopies. If the project goal includes restoration of amounts of large wood in streams, more than 50 to 150 years may be required before the streamside forests begin to deliver wood to streams.

The recovery of populations depends upon rates of birth and death. Species that reproduce rapidly and produce large numbers of offspring may recover quickly after restoration is implemented. In contrast, species that reproduce and mature slowly and produce low numbers of offspring will require much longer (decades to centuries) to recover.

Table 2. Factors that deterimine the timeframe for responses to restoration efforts.

	Recovery period			
System attributes	**1–10 years**	**10–50 years**	**50–100 years**	**100–1000 years**
System complexity	Simple	Simple	Complex	Complex
Control of inputs	Simple to control	Simple to control	Difficult to control	Difficult to control
Flow paths	Rapid	Intermediate	Slow	Very long and slow
Storage of nutrients, toxics, sediments, or human additions	Low	Moderate	High	High
Reproductive rates of native biota	Rapid	Rapid	Slow	Slow
Required stages of succession	Succession not required	Early stages	Mature stages	Late stages
Legacies of native ecosystems	Abundant	Abundant	Few	Few to none
Influence of alien species	Little	Slight	Extensive	Extensive and dominan
Degree of landscape alteration	Minor	Intermediate	Major	Major and irreversible

If land use practices causing ecological degradation continue after restoration efforts, recovery will not occur as rapidly. The degree to which pressures are placed on the recovering resources determines the rates of recovery. For example, some restoration of riparian areas involves establishment of livestock grazing exclosures. Such exclosures may encompass complete exclusion of livestock grazing or limited seasonal use. The amounts and timing of grazing can greatly influence the rates and degree of riparian and aquatic system recovery.

Couplings between the physical landscape and biological communities take time. Floodplain restoration requires reestablishment of periodic inundation. In turn, this results in changes in sediment deposition and channel change. In response, floodplain vegetation can be altered, and the composition of plant communities shifts through time as succession occurs. In turn, future floods interact with developing floodplain forests, changing the patterns that developed previously. Such interactions can proceed for decades, and outcomes of restoration efforts will reflect these changes.

Future directions to make restoration more effective

We have explored several fundamental temporal perspectives of ecological responses to restoration and conservation practices. But the larger question is how can communities and natural resource agencies become more effective in the conservation and restoration practices applied to agricultural landscapes? We suggest six major approaches that offer substantial promise to create more effective conservation and restoration: (1) Greater consideration of producer/landowner attitudes and knowledge, (2) more effective in-field practices and planning, (3) greater emphasis on effective monitoring and assessment, leading to refinement of policies and practices, (4) adoption of landscape perspectives in planning and applying conservation practices, (5) development of conservation markets, and (6) expansion of the use of alternative future scenarios.

Producer/landowner attitudes and knowledge

Agriculturalists value the culture, environmental worth, and aesthetic characteristics of their land, but personal opinions on the values of natural amenities vary. Often, one person's wildflower is another's weed. For the most part, however, those involved in agriculture embrace a desire to improve the quality and productivity of land to be passed on to future generations (Lubchenco, 1998; Wildlife Management Institute, 2006). Management philosophies guiding contemporary agricultural land use have evolved largely on the perception that composition, diversity, and ecological relations between farmed and nonfarmed land play only a small, if any, roll in productive agricultural systems (O'Riordan, 2002; Kirschenmann, 2003; Keeney and Kemp, 2004). Agricultural ecosystems are no less complex than any other ecosystem. Variability in frequency and types of land use, diverse goals of landowners, skepticism about outside intervention in management decisions, and suspicions about regulation contribute additional layers of complexity in addressing environmental issues associated with agricultural land use.

The effectiveness of conservation programs is ultimately defined by the willingness of landowners to participate and their knowledge of conservation practices and their benefits. Long-term solutions to entwined issues, such as soil erosion, water quality, and wildlife habitat, will be achieved only when conservation policies are embraced across multiple farmsteads to the watershed level. Incorporation of landowner knowledge about local issues and production challenges, coupled with forethought directed to their expectations and limitations, will elevate interest and create opportunities to improve the level of landowner knowledge required for successfully implementing conservation practices and programs. The most proficient way to get information to farmers about the benefits of conservation is to have it delivered by a neighbor who has seen success. This can then be followed up with educational activities to improve landowners' abilities to implement conservation practices successfully.

Large-scale assessments of conservation effectiveness based on sophisticated modeling are necessary for understanding effects of and refining conservation policies. Such approaches rarely, however, furnish site-specific answers to those who have invested time, labor, and trust in adoption of conservation practices on their farm. Approaches for describing on-farm or within-watershed effects of conservation are needed to strengthen and justify program participation. Many landowners who enroll in conservation programs value the environmental benefits associated with their conservation activities and want to know how well conservation practices are working on their farms. Some landowners are willing to participate in the collection of information needed to describe effectiveness of conservation policies (Wildlife Management Institute, 2006). Programs such as the Izaak Walton League's Save Our Streams (Izaak Walton League of America, 2006), where landowners are trained in sampling and identification of aquatic insects to estimate changes in water quality brought about by adoption of conservation practices, can serve as models for involving willing landowners in monitoring conservation effectiveness. Identification of specific, regionally important species as management and monitoring priorities, addressing effects of conservation practices on multifarm or watershed scales, consideration of landowner goals/limitations, as well as finding ways for willing landowners to become part of monitoring activities will improve abilities to furnish meaningful results needed to refine the performance of agricultural conservation programs.

Innovation in farm operations and waste management systems

A key factor in conservation practice effectiveness is timely adoption. Practices that are simple, easy to implement, and fit well into the agricultural operation are those most likely to be adopted by a significant number of producers. Use of precision agriculture, nutrient management, integrated pest management, on-site wastewater treatment, improved buffer designs (e.g., carbon-source trenches for enhanced denitrification), and improved livestock nutrition to reduce nitrogen and phosphorus in manures offer potential to increase the effectiveness of future restoration efforts. More specific innovations include the following:

- Use of existing in-field conservation practices (nutrient management, integrated pest management, conservation tillage, etc.) that reduce production costs and reduce resource loss from the field.
- Targeting implementation of conservation

practices by identifying critical source areas within fields or landscapes.

- Elimination of agricultural subsidies that distort costs and encourage producers to over apply agricultural chemicals and farm marginal land that would not otherwise be economically productive.
- Implement conservation programs and practices that measurably improve the environment rather than those only presumed to protect the environment.
- Evaluate and improve success of conservation programs/activities by measuring improvements in environmental quality.
- Fund only conservation programs and activities that have explicit, measurable environmental goals.

Assessment and monitoring

Given the large investments of public funds in conservation and restoration actions, any prudent society would want to determine whether its efforts are successful. But observations and assessments of conservation program performance require a commitment of effort and funds. Because so few restoration programs are monitored, little information feeds back into the policy formulation and decision-making processes. As a result, adaptive management occurs most often through sequential but disconnected correction measures or emergence of new programs. A recent review of river restoration projects found 20 percent had no defined objectives, and only 10 percent included any form of assessment or monitoring (Bernhardt et al., 2005a). Post-project assessment often focuses more on implementation (e.g., how many acres or stream miles have been treated) rather than achievements of intended environmental goals, such as measurable reduction in agricultural chemicals entering surface waters.

One of the major reasons for the low rates of monitoring and assessment is the relative cost of restoration actions versus monitoring and assessment. Most people and agencies are well intended and want to invest as much as possible in actual restoration activities. As a result, few projects dedicate funds and effort to determine whether the projects are truly successful in meeting environmental objectives, trusting that implementation of the practices alone meets program goals.

For many projects, the timing of monitoring is poorly matched to realization of expected responses. A familiar example is planting of riparian vegetation intended to reduce soil erosion, increase bank stability, increase shade, lower stream temperature, and enhance water quality, as well as the abundance, diversity, and health of fish, wildlife, and other organisms. Typically, such projects are evaluated for two to five years after establishment to determine survival of the planted vegetation. In that two- to five-year interval, it is unlikely the plant communities could develop to a stage in which they provide the intended ecological contributions (e.g., canopy cover, food inputs, wood, channel complexity). Twenty to 50 years or more is a much more realistic time horizon for recovery of many of these ecological functions.

Nonetheless, many involved in restoration understand the long-term nature of the process. In a survey of Pacific Northwest watershed councils, Bash and Ryan (2002) noted, "Many respondents indicated that short-term project assessments might not be meaningful given the time frame needed to evaluate the outcome of restoration projects."

It is highly unlikely that funds and workforce will ever be adequate to monitor and assess a large portion of the conservation or restoration actions on agricultural land. One option to provide rigorous assessment of conservation and restoration is creation of a "monitoring bank." Various projects throughout a region, from a variety of sources, could invest in a common fund that would support scientifically rigorous assessments of the major conservation and restoration actions applied to agricultural land in the region. Sites could be randomly selected from a systematic database, with factors being measured or monitored that reflect the greatest need for information identified by a ranking process that includes priorities from all agencies contributing to the monitoring bank. Conclusions drawn from study results could be scaled appropriately to the spatial and temporal scales that reflect regional applications for the intended conservation and restoration outcomes. Such an approach would eliminate duplication of monitoring efforts and maximize results from funds allocated for monitoring and assessment of conservation and restoration practices for all agencies involved in the program.

Achieving conservation effectiveness at landscape scales

The multiscale nature of watershed processes requires a watershed approach to management, but effective management of watersheds is challenging in landscapes under multiple ownerships (Allen el al., 1997). NRCS provides technical assistance to develop comprehensive resource management systems on land that may or may not be involved with conservation-oriented management. Practices implemented within the framework of a resource management system effectively protect soil and water quantity and quality as well as associated terrestrial wildlife communities. With such practices in place, aquatic species are also likely to benefit. Sedimentation of streams causes damage to habitats of all aquatic species, but that damage can be diminished when beneficial land management practices are implemented at broad scales (Lenat, 1984) and coupled with riparian conservation practices at smaller scales (Stauffer et al., 2000). Indices of biotic integrity provide insight on the effects of these practices on aquatic fauna at both scales (Lammert and Allan, 1999; Weigel et al., 2000).

Finding collaborative ways for landowners to maintain or restore connectivity of habitats should contribute to ecological restoration across wider geographic scales. For example, use of "best development practices" to improve the trajectory of amphibian populations has showed promising results when implemented cooperatively at the town level in Vermont (Calhoun et al., 2005). Maintaining contiguous riparian zones, or buffers, of adequate width along streams and rivers has been shown to correlate highly with improvements in indices of biotic integrity for aquatic fauna in Wisconsin (Weigel, 2003).

Conservation markets for regional communities

Assessments have traditionally overlooked the economic gains that can result from adoption of conservation practices. Mitigation banking has been used most widely to provide conservation benefits while also creating economic opportunities. Pollution trading is emerging as a major economic choice in response to TMDLs and other regulatory criteria. Also, state agencies are beginning to implement conservation payments to offset consumer impacts (such as large sport-utility vehicles). All of these create opportunities for farmers to implement conservation practices that potentially increase their income.

Focus on future demands and challenges rather than past practices

All too often regional assessments of conservation and restoration focus on examination of ecological conditions assumed to be related to past and current land use. Rarely are potential consequences projected for the near future (approximately 50 years). Consequently, as problems of the past are addressed, management typically fails to anticipate future challenges. Emerging resource issues are repeatedly addressed with tools designed to repair the consequences of past land use and management practices. Immediate or short-term responses often are considered to have greater likelihood of success; they often are perceived as being more credible and defensible than accepting the risk of addressing unknown changes in policy and management that might potentially affect long-term changes in resource availability or environmental conditions. As a result, decisions tend to favor near-term choices affecting small, local areas.

A proactive, longer term tool potentially applicable to management of agricultural landscapes is assessment of alternative future scenarios. Alternative-futures analysis has been used to explore future trends in the Willamette River Basin (Baker et al., 2004), as well as the San Pedro River in Arizona and Camp Pendleton in California (Steinitz et al., 2003, 2005). These assessments of future trends provide spatial projections of alternative choices about land uses and the potential environmental, economic, and social consequences of those alternatives.

A study of future alternatives for Arizona's San Pedro River demonstrated that availability of water will have the greatest impact on future ecological conditions in this arid region (Steinitz et al., 2005). Irrigation withdrawals were projected to have the greatest potential impact on ecological processes, but policies that encouraged population growth and relaxed constraints on development also would have major impacts on water and ecological conditions. A study of land use alternatives in the upper Midwest examined people's choices for residential development in an agricultural region, finding that a majority preferred landscapes with natural vegetation and higher ecological conditions (Nassauer et al., 2004). Though questions of rural land conversion remain, the communities clearly view an ecologically healthy landscape as a more livable environment.

Environmental changes under alternative futures can be evaluated quantitatively through simulation models or observed relationships and qualitatively through expert judgment or the Delphi approach (Hulse and Gregory, 2001; Hulse et al., 2002). Mechanisms for identifying assumptions and spatial representation of alternative future scenarios are just as important, however, as are methods for analyzing alternative futures. Three approaches have been used in recent years—stakeholder-derived, expert-derived, and model-based scenarios. Each approach has strengths and weaknesses. Stakeholder processes employ citizen stakeholder groups to define assumptions about how future land and water use will unfold. Those scenarios can be used with planning processes and models to produce maps of potential future land and water use, translating the stakeholder assumptions into mapped form. The stakeholder approach has the advantages of citizen involvement, greater political plausibility, and an increased likelihood of institutional acceptance. But stakeholder–driven processes have one disadvantage: They do not statistically quantify the likelihood of various alternatives, and the number of alternatives produced (three to ten) is typically limited.

A second common approach for creating mapped alternative futures is expert judgment, with professionals in the biophysical and social sciences defining processes and rates of transition that may determine future land and water use conditions. Alternative futures produced from expert judgment have the advantage of quantifiable statistical likelihood (based on the larger number of alternatives produced), but suffer from unclear political plausibility and a lack of citizen involvement, which often limits their credibility in affected communities.

Simulation modeling has been used to define alternative futures by representing the rules by which people make decisions and then projecting probable effects across the landscape. Simulation models can produce thousands of possible future landscapes, with the advantage of representing the statistical likelihood of various alternatives. An additional advantage of simulation models is the ability to create and run new alternatives quickly.

Trajectories of land use and environmental change from 1850 to 2050 were developed for the 30,000-square-kilometer (11,583-square-mile) Willamette River Basin in Oregon, a basin comprised of approximately 25 percent agricultural land, 65 percent forest land, 6 percent urban land, and 4 percent rural residential land (Baker et al., 2004). Human population in the basin is expected to increase from 2.2 million to more than 4 million by 2050. Three spatially explicit future scenarios were developed by a group of stakeholders: (1) a Plan Trend 2050 scenario in which current policies and practices continue through 2050, (2) a Development 2050 scenario in which market forces are allowed to influence land use change and current land use policies are relaxed, and (3) a Conservation 2050 scenario in which additional, plausible conservation and restoration practices are implemented. Scenario outcomes were evaluated on the basis of land cover change, water availability, and models of ecological conditions for fish, macroinvertebrate, and wildlife communities.

Incorporation of conservation practices in Conservation 2050 enhanced wildlife habitat without significantly altering the function of the agricultural system. Development 2050 also showed local improvement in wildlife habitat due to increases in natural vegetation associated with the developed environment. Plan Trend 2050 indicated little change in habitat quality because few modifications were made to agricultural land.

The Willamette Valley contained approximately 240,00 hectares (620,000 acres) of prime farmland in 1990, almost all of which remained in agricultural production (1 percent was converted). Under the Development 2050 scenario, approximately 25 percent of prime farmland would be converted to other uses, leading to fragmentation and conversion of agricultural fields. Under the Conservation 2050 scenario, 15 percent of prime farmland would be converted to field borders, low-input crops in sensitive areas, and conversion of cropland to native vegetation. Development scenarios tended to prefer areas of prime farmland, while restoration activities tended to focus on lower quality, less productive farmland.

One of the most important findings of the alternative-futures analysis is that both the Plan Trend 2050 and Development 2050 scenarios show either little change or continued decline in natural resources (Figure 1). In sharp contrast, indicators of natural resource condition improve substantially under the stakeholders' assumptions about plausible restoration measures in the conservation 2050 scenario, recovering 20 to 70 percent of the losses sustained since settlement in the mid-1800s. Citizens and decision-makers in the basin now have geographic projections over the next 50 years, indicating conservation and restoration practices are likely to produce significant ecosystem benefits while accommodating the projected increase in the human population.

An agent-based model, Evoland (Evolving Landscapes), was developed to examine ecological and economic consequences of alternative futures for floodplains and riparian areas of the Willamette River Basin (John Bolte, Oregon State University, personal communication). This modeling approach allows rapid analysis of many alternative futures, measurement of variance based on probabilities of land use choices, and modification of assumptions and policies defined by user groups. Results of modeling alternative policies clearly demonstrate conservation and restoration policies can be effective in restoring ecological function in the long run (20 to 40 years), but ecological conditions respond to conservation and restoration actions more slowly than they do in response to economic and social policies. An additional concern raised focuses on effectiveness of adaptive management. If policies were implemented that would result in short-term economic gain, but cause floodplain and riparian degradation not evident for 20 to 30 years, adaptive management would be ineffective in the face of the substantial financial investments that would have occurred before the undesired outcomes were realized. The timing of restoration outcomes will be constrained by the competing processes of intensified land use and land use conversion.

Making decisions for generations

In his 1999 book *The Clock of the Long Now*, Stewart Brand addresses the challenge of incorporating different time scales into the decision-making process. He asks, "How do we make long-term thinking automatic and common instead of difficult and rare, and how do we make the taking of long-term responsibility inevitable?" Tools and ways of thinking have to be changed so that the "long now" is inherent in the management questions asked and the solutions explored. Because environmental and social consequences of modern agricultural production reach from the heart of this continent into coastal and marine ecosystems, we can no longer measure agricultural accomplishments simply on economic returns brought about by traditional farm products.

Unfortunately, there has been an inclination to define the agricultural landscape as being composed of either "working" or "conservation" land. This regrettable distinction, born in part by the structure of existing conservation programs, fails to recognize that all land, regardless of production status, is part of the "working" agricultural ecosystem. An economically viable, environmentally sound, and, therefore, socially supportable agricultural industry will be possible only when agriculture protects and even perhaps enhances the natural and cultural resources upon which it stands.

Budgetary constraints increasingly force decisions affecting how conservation programs are designed and administered. Successful conservation policies can be publicly and politically supported only when their effectiveness is known. To gain such knowledge requires an unrelenting commitment to calculate both immediate as well as long-term effectiveness of programs and refine conservation policies as information becomes available. The reality that must be faced is hard numbers that either support or disprove the success of conservation and restoration activities will not appear quickly, nor will they come without a commitment to fund the research required to define acceptable solutions.

Traditional conservation and restoration practices will continue to be used. Well-intended landowners and community groups will continue to try to sustain and restore declining resources in the face of growing human populations and their need for agricultural commodities. There will be no easy answers, and good intentions alone will not suffice. The tremendous power of the ratchet effects in place in society—extinction of species, generational views of resource abundance and landscape condition, and economic pressures that require continued or accelerated commodity production—must be faced. And through the

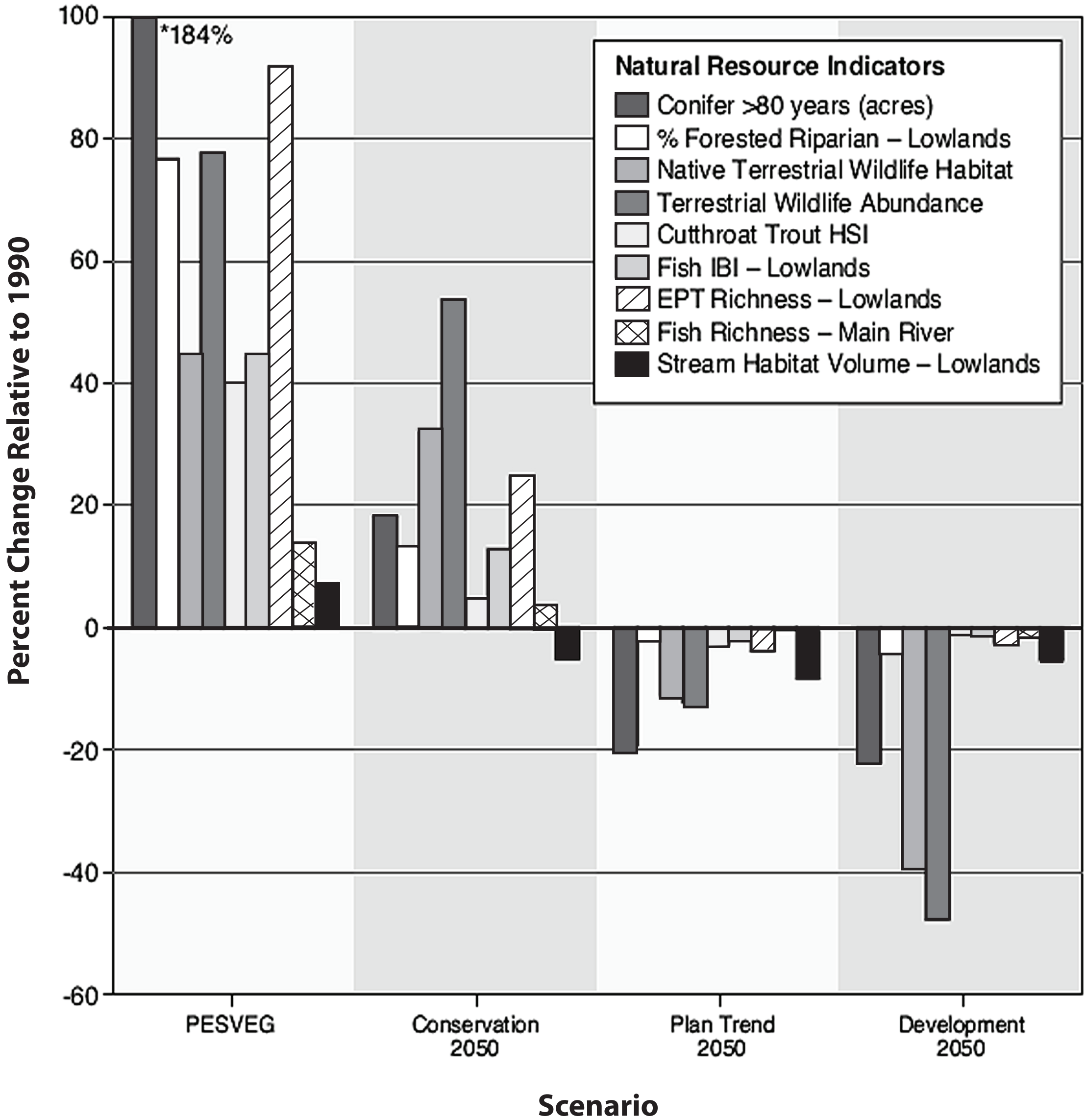

Figure 1. Percent change in measures of natural resource condition in the three future and pre EuroAmerican scenarios relative to 1990 land use and cover in the Willamette River Basin. Source: Baker et al., 2004.

temporal perspectives explored in this paper, the timeframes of both conservation and restoration must be carefully and clearly explained to avoid the ratchet effect of assuming these practices will be immediately and fully effective. It cannot be assumed that continued or accelerated demands on natural resources can be counterbalanced by conservation and restoration measures alone. The uncertainty in that assumption, even when balanced with more realistic expectations of timeframes, must be adjusted with a "margin of safety" for natural resources, just as engineers would use in designing any road or building. Landowners and resource managers must balance the immediate impacts of their actions against the current rates of resource restoration. The actions taken today determine the extent to which the world will sustain the next generation. People today owe it to the next generation to base today's decisions on realistic expectations about practical timeframes for achieving ecological restoration and conservation.

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Roundtable: Realistic expectations of timing between conservation and restoration actions and ecological responses

Roundtable participants engaged in a wide-ranging discussion on many topics, most of them at least somewhat related to "realistic expectations." Among those topics were the following:

- Responses to environmental degradation are often technological fixes, but are the right end points being measured? The baseline of the "healthy" condition is often not known. Reversion to pristine conditions is impossible. "Recovery" is a healthy, diverse ecosystem, not native condition. The nitrogen cycle is distorted; the phosphorus cycle is broken; and hydrology has been altered. Balance and quality control are needed, but the economics does not work out. The Chesapeake Bay project was offered as an example.
- Ecological trajectories must be assessed to determine where they will lead in the future. The historical context is an important starting point from which to look forward and understand the trajectory of change. Factors must be assessed that cause changes in trajectories; what-if scenarios must be examined; and future scenarios from models must be developed. Population growth and pressure must be considered in these scenarios, along with climate change.
- How can people relate to realistic expectations? Realistically project or even come up with expectations? What limits what we can realistically expect or how we can change expectations? What directs the evolution of value systems through generations? Political will is needed to bring "realistic expectations" to reality, perhaps more than scientific or stakeholder interests.
- In considering expectations, the focus must be on progress—the right trajectory—rather than just end results.
- How should understanding of effects and expectations be scaled up from individual fields to entire watersheds?
- Agencies and other institutions continue to be data rich and information poor. Scientists could help by sorting out the key questions that might help turn existing data into useful information.
- Public involvement and sorting out what the public wants for the future is important. Community visioning processes and other exercises that help identify what is realistic and believable can help. The costs and behavioral changes involved need to be included in these processes.
- Policymakers must realize that conservation and restoration are long-term processes. Meaningful responses to conservation cannot be expected in the time frame of individual farm bills (five to seven years). Conservation effectiveness will require much longer time frames.
- Regional priorities must be defined that are meaningful to local farmers and populations. Environmental goals that are unrealistic and do not support reasonable integration of conservation and viable continuation of agricultural land use will not be accepted by farm operators.
- Monitoring of conservation effectiveness must be part of all conservation programs. A relatively small amount of high quality data can be used to extrapolate results to much larger

areas and programs. But program managers must have the data, budgets, and long-term commitment to collect such information.

- Long-term monitoring of the effectiveness of agricultural conservation will require not only provision of financial support but development of an infrastructure that will support long-term collection of useable data and results. This will require setting measurable, reasonable goals and identification of an agency responsible for training, data quality control, interpretation of results, and getting those results to the public and people who make long-term agricultural policy decisions (U.S. Department of Agriculture officials and political representatives in Washington, D.C).

Roundtable participants then reached consensus on a series of leading questions that at least implied what the most important next steps might be in strengthening the science important to agricultural conservation:

1. How do we identify reasonable expectations? How do we communicate them to the public and policymakers? How do we receive communications back from the public and policymakers? How do we make adaptive management work in the "real world," that is, how do we involve the public in adaptive management (and who are "we")?
2. How can we develop a process to identify and influence trajectories of change and do so at an ecosystem/landscape level rather than a localized, single-issue level? What are the costs and benefits of alternative trajectories? There are many measures to assess in evaluating alternative future scenarios. A process for doing this has been used in some areas, but is not widely available or widely known.
3. What questions do we need to ask and answer to turn data into information that can be used to refine realistic expectations? Where do we need more data, and where do we just need to analyze what we have?
4. What is an appropriate timeframe in which to develop reasonable expectations? What are people's/politicians' typical timeframes? How do "realistic" expectations change when the time frame is 2 to 4 years, 10 years, a generation, 100 years, or more?
5. Realistic expectations are subject to change over time. What factors, both catastrophic and evolutionary, cause perceptions of what is realistic to change? What can we do to avoid being only passive participants in this process?

Direct Payments to Conserve Biodiversity

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POLICY FORUM: ECOLOGY

Direct Payments to Conserve Biodiversity

Paul J. Ferraro and Agnes Kiss

The international community has invested billions of dollars to stem the loss of biodiversity in developing nations (*1*, *2*). Despite these investments, the loss continues (*3*, *4*).

Biodiversity is a public good and thus is not supplied in sufficient quantities by individuals acting in their own self-interest. Conservation practitioners try to provide individuals who destroy ecosystems and species with incentives to preserve them. These incentives lie on a spectrum from indirect to direct with respect to their link with conservation objectives (see figure, this page). Conservation initiatives in the United States, Australia, and most of Europe increasingly emphasize more direct incentives: land purchases, leases, and easements, as well as financial incentives such as performance payments and tax relief. For example, the U.S. government spends over \$1.7 billion per year to induce farmers to protect land (*5*), and The Nature Conservancy, with an annual budget of more than \$700 million, operates almost exclusively through land purchases and easements (*6*, *7*).

These payment approaches are based on a willing buyer–willing seller model. Sellers deliver conservation outcomes in exchange for a negotiated payment in cash or in kind. Payments are conditional on conservation outcomes.

Conservation in developing nations has emphasized the more indirect end of the spectrum. Indirect approaches include initiatives like Integrated Conservation and Development Projects (ICDP) and Community-Based Natural Resource Management. Such projects encourage rural communities to maintain biodiversity by helping them to use it sustainably. They may also provide alternative sources of products, income, or social benefits (schools, wells, clinics, etc.) as a means of encouraging communities to cooperate. These kinds of efforts have been referred to as "conservation by distraction" (*8*).

After decades of global efforts to conserve biodiversity through indirect approaches, there is a growing recognition that such initiatives rarely work. Some authors (*9*, *10*) have pointed to basic conceptual flaws; for example, people are more likely to incorporate new sources of income as complements to existing activities rather than as substitutes for them. Others have noted that the technical, economic, social, and political conditions needed for an indirect approach to succeed are difficult to find in the real world (*11*, *12*). For conservation initiatives that encourage extractive activities (e.g., nontimber forest product collection), sustainability is a key concern (*13*–*15*). A recent review of ICDPs (*16*) declared that there was "a notable lack of successful and convincing cases where people's development needs have been effectively reconciled with protected area management."

Potential Investments for Biodiversity Conservation

Investment	(Least direct)	Examples
Support for the use/marketing of extracted biological products		Logging, nontimber forest product extraction, and hunting
Subsidies for reduced-impact land and resource use		Sustainable agriculture on already cultivated lands, "alternative income generation"
Support for the use and or marketing of biodiversity within relatively intact		Eco-tourism, sport hunting, bioprospecting, wild honey production
Payment for other environmental services (generating biodiversity conservation as a side benefit)		Watershed protection, carbon sequestration
Payment for conservation land or "retirement" of biodiversity use rights		Easement, "nonlogging" concessions
Performance-based payment for biodiversity conservation	(Most direct)	Paying for bird breeding success, paying for occupied wolf dens

Indirect Versus Direct Approaches

Potential obstacles to implementing a direct payment approach in developing nations include uncertain or inequitable land tenure, limited experience with and enforcement of legal contracts, and limited local opportunities for nonagricultural investment or employment. Direct payments may displace biodiversity loss to other areas, may be misappropriated or misused, and may create social conflict. However, these problems generally apply equally to indirect interventions.

Direct payments might be seen as a form of bribery or an imposition of Western values on developing nations. However, investments that encourage eco-tourism or create markets for tagua nuts are equally aimed at inducing rural communities to change their land use and livelihoods in response to Western values.

Recent debates (*17*) have highlighted four issues that need be examined in relation to direct and indirect approaches.

1) *Institutional complexity*. Indirect and direct approaches require institutions that can monitor ecosystem health, resolve conflict, coordinate individual behavior, and allocate and enforce rights and responsibilities. A system of conservation payments, however, allows practitioners to focus their energies on designing the requisite institutions. Existing direct payment initiatives have estimated administrative costs from 5% to 25% of the operating budget (*18*–*20*), whereas ICDPs have administrative costs at least as high, and often higher (*21*). A developing nation may not have the institutional capacity to make contractual agreements and to manage money in a direct payment initiative. If, however, it lacks such capacity, it would not likely have the institutional capacity to implement a more complex indirect intervention.

2) *Costs*. In general, a direct payment approach will be more cost-efficient than any indirect approach (*8*, *22*). For example, an analysis of a conservation intervention in southeastern Madagascar (*22*) indicates that, were the nearly \$4 million of available conservation funds invested in annual payments conditional on the protection of forest, about 80% of the original forest could have been protected into perpetuity, whereas only 12% could have been protected through support of indirect incentives. Furthermore, rural residents receiving conservation payments would have received incomes two times those that could be generated through an indirect in-

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tervention. The basic principle is that the cheapest way to get something you want is to pay for what you want (e.g., protected rain forest), rather than pay for something indirectly related to it (e.g., capital for improving eco-tourism), or more simply "you get what you pay for."

Paying people to protect habitat and wildlife can be surprisingly affordable. Many of the regions in which conservation practitioners work are at the margins of the economy where other land uses do not generate substantial net returns. For example, the middle-income nation of Costa Rica pays rural residents about $35 annually per hectare of forest protected, and excess demand for conservation contracts suggests that these payments are higher than necessary (*23*). Even cheaper, Conservation International is protecting 81,000 hectares of rain forest in Guyana through a conservation concession that costs $1.25 per hectare per year (*24*), and The Wildlife Foundation in Kenya is securing migration corridors on private land through conservation leases at $4 per acre per year (*25*, *26*).

We are not arguing against short-term assistance for profitable, eco-friendly activities that can protect biodiversity. Conservation practitioners and donors, however, must ask themselves why external assistance is necessary if these activities are so profitable (*27*). Rural residents may face credit constraints, misunderstand the benefits conservation would afford them, or be unable to organize to realize the benefits, but we suspect that such conditions are rarely the main constraints.

3) *Development benefits*. The indirect approach is attractive to many stakeholders because it seems to achieve conservation and development objectives simultaneously (despite evidence suggesting it achieves neither in most cases). However, direct payments benefit poor farmers by improving cash flows, providing a fungible store of wealth, and diversifying sources of household income. Furthermore, under a payment approach, the land holders/resource users decide how best to meet their own goals and aspirations, rather than being subsidized to carry out predetermined activities as is the case under the indirect approach.

Paying an individual or community for "not doing something" might be seen as a form of social welfare rather than development. However, the idea that conservation payments are a form of welfare belies what conservationists have been arguing for decades: Biodiversity is a valuable commodity and biodiversity protection is an alternative land use.

4) *Sustainability*. The Holy Grail for the international conservation community is the self-financing conservation activity. Direct payments are seen as undesirable because they require an ongoing financial commitment to maintain the link between the investment and the conservation objectives. Like the legendary Holy Grail, however, the self-financing conservation activity is elusive. Indirect approaches are also likely to require a sustained flow of funds over time. A recent World Bank analysis of ICDPs (*16*) argued that conservation initiatives "based on simplistic ideas of making limited short-term investments in local development and then hoping this will somehow translate into sustainable resource use and less pressure on parks need to be abandoned."

Future Prospects

Direct payment initiatives are rare in developing nations, but conservation pioneers are experimenting with them. A recent symposium (*17*) highlighted the use of forest protection payments in Costa Rica, conservation leases for wildlife migration corridors in Kenya, conservation concessions on forest tracts in Guyana, and performance payments for endangered predators and their prey in Mongolia. South Africa and American Samoa have over a decade of experience with "contractual national parks," which are leased from communities. Other payment initiatives are being designed or are under way in Mexico, El Salvador, Colombia, Honduras, Guatemala, Panama, Russia, and Madagascar (*28*). Payments can be made for protecting entire ecosystems or specific species, with diverse institutional arrangements existing among governments, firms, mutilateral donors, communities, and individuals.

Direct payment approaches are not "silver bullets" that can be applied immediately and easily in all situations. Furthermore, broader policy interventions, such as removing perverse direct and indirect subsidies that encourage the loss of habitats and their biodiversity (*29*, *30*), are also needed. However, people will generally do what is in their own interest, particularly their short-term interest. If they can receive more benefits from clearing an area of habitat than they could from protecting it, they will clear it. A society would never think to provide a public good like national defense through indirect means. The conservation community must reconsider its attempts to provide biodiversity through indirect means. If we want to get what we pay for, we must start tying our investments directly to our goals.

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RUPES: Rewarding upland poor for environmental services

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4. Raising awareness of the value of the environmental services

Without basic understanding at all levels of the social and environmental benefits that can emerge from rewarding upland communities for environmental services provided, this innovative approach will not develop, expand, and have an impact. Emphasis will be placed on linking environmental actions at local levels those that benefit from them, including the global community. To accomplish this, program results in the form of research and other experiences derived from the program will be circulated widely.

5. Forming effective partnerships

Throughout the program, a broad array of partnerships will be developed and nurtured. This will result in a strong consortium of research and development partner organizations that are engaged with national and local governments and non-governmental organizations at all levels. This network of partnerships will facilitate the collaboration to accelerate the development of environmental services agreements throughout Asia, within and outside the program.

6. Establishment of a viable 'facility'

Towards the end of the program it is expected that the options for effective environmental service rewards are sufficiently clear that the organizational aspects of a 'facility' to ensure an appropriate and sustainable institutional approach to foster transfer payments to the poor will merit full attention.

IMPLEMENTATION

Through the work of the consortium partners, the RUPES Project will undertake action research that will look at testing rewards or potential rewards and reward mechanisms at a number of sites throughout Asia. RUPES action research sites have been established in Indonesia, the Philippines, and Nepal and will expand to other countries such as southern China, Vietnam, Laos, India and Sri Lanka.

IMPACT OF RUPES

The primary impact of RUPES will be to create and study experience on the use of environmental reward transfers as a tool for promoting effective and sustained environmental management while at the same time increasing benefit flows to poor upland communities. The main result will be a deeper and more practical understanding of how to formulate such arrangements, their viability and potential for wider use. The RUPES initiative will serve as an intellectual focal point for collection and analysis of experience derived for these innovative approaches. Experience and analysis will feed directly into government planning for environmental management and poverty alleviation in the uplands of selected countries in Asia.

The impact on poverty alleviation will likely come from rewards to upland communities taking the form of secure land tenure, development assistance such as credit, market infrastructure, improved/expanded extension service, particularly in terms of better access to quality germplasm for trees or other agricultural products and when appropriate, direct financial payments. The emerging market for carbon, whether or not linked to offset arrangements, offers the most immediate potential opportunity for the upland poor.

As more experience is gained and analyzed in this and other environmental service markets, the greater the potential for magnifying impact beyond the initial RUPES areas.

WANT TO BECOME MORE INVOLVED WITH RUPES?

There are a number of opportunities to become involved in the RUPES Program both at an international and a national level.

Nomination of an action research site in the project, contribution to studies and assessments undertaken at the RUPES sites, sharing the results of similar work being carried out elsewhere that can contribute to the RUPES knowledge base – all these are ways to participate.

If your organization or institution would like more information on RUPES or would like to be involved in the RUPES program please contact us.

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RUPES
Rewarding Upland Poor for Environmental Services

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

IFAD
INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT

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GOAL

To enhance the livelihoods and reduce poverty of the upland poor while supporting environmental conservation at local and global levels

BACKGROUND

Among the vast multitude of the poor in Asia, the populations that are most marginalized are those living in the hilly and mountainous areas. The benefits of national and local investments in economic development often bypass these upland communities and in many cases they are bearing a large share of the negative aspects of development.

It is increasingly evident that the real plight of mountain and upland poor communities has been overlooked. There is an urgent need to support a process of self-empowerment so that poor upland people can take the necessary decisions to build a sustainable future based on their resources, on improved technology and centuries of accumulated wisdom.

We now know that many upland and mountain communities in Asia manage landscapes that provide environmental services to outside beneficiaries. The services they provide include clean and abundant water supplies from watersheds, biodiversity protection, stocks of carbon that may alleviate global warming and landscape beauty for recreation and tourism. However upland communities are not sharing in the benefits that these services provide. Rewarding the poor upland communities for providing environmental services would enhance their livelihoods and reduce poverty.

A PROGRAM FOR DEVELOPING MECHANISMS FOR REWARDING THE UPLAND POOR IN ASIA FOR THE ENVIRONMENTAL SERVICES THEY PROVIDE (RUPES)

Through partnership with the International Fund for Agriculture and Development (IFAD) as a major donor, the World Agroforestry Centre (ICRAF) has taken on the role of coordinating a consortium of partners interested in contributing and being a part of RUPES. These include such organizations as the Center for International Forestry Research (CIFOR), World Resources Institute (WRI), World Conservation Union (IUCN), Winrock International, Conservation International (CI), the Economy and Environment Program for Southeast Asia (EEPSEA) of the International Development Research Centre (IDRC), Ford Foundation, The Nature Conservancy (TNC), International Institute for Environment and Development (IIED), Worldwide Fund for Nature (WWF), national partners from the countries in Asia where RUPES is conducting action research, and other international and national investors in poverty alleviation and natural resource management.

THE STRATEGY

The RUPES Program will build working models of best practices for successful environmental transfer agreements adapted to the Asian context. It will conduct targeted action research at a number of sites across the region to examine and explore what are the environmental services and how can they be measured. Mechanisms to anticipate and prepare for changes to environmental services will also be considered as part of the program.

The program will look at whom the rewards should go to, who will pay the rewards, how and in what form they would be collected and what amount or form is appropriate. The action research will define appropriate methods with the beneficiaries for best practice in environmental transfer payments. It will provide simple, practical examples of how innovative, institutional arrangements and reward mechanisms can be applied to foster local development, while at the same time preserving and restoring the environment.

The emphasis will be on easily understood, sound and financially and institutionally sustainable approaches.

There will be a particular focus on the development and strengthening of local institutions associated with environmental transfer payments. Networking at global, regional and national levels will be another key element of the RUPES Program.

CHALLENGES

There are a number of significant questions that must be answered as environmental transfer payment mechanisms are explored and put into place to reach the upland poor. The research and development activities that form the RUPES program include:

1. Quantifying environmental services

Practical and cost-effective methodologies will be applied for quantifying environmental services adaptable to upland settings. Indictors of environmental services – watershed services, biodiversity conservation, carbon stocks and socioeconomic indicators will be examined in terms of who generates these services and who benefits from them, under various land use practices.

2. Developing successful environmental service agreements

It is unlikely that a single reward mechanism for providing environmental services meets all situations. Thus, an array of mechanisms will be formulated in terms of likely impacts on land use choices, information, monitoring and enforcement costs, and the supporting policy framework. The mechanisms should benefit the rural upland poor in a way that is cost effective, so as to reduce both poverty and environmental problems.

3. Supporting a transparent and enabling environment

In order for systematic transfers of rewards to upland communities for the environmental services they provide to take place, constraints that inhibit such transfers must be identified and addressed. These constraints can take the form of a lack of political will, institutional capacity, lack of a supportive legal framework, conflicting and competing government jurisdiction, financial resources and even limited community interest and commitment.

Paying for environmental services of silvopastoral practices in Nicaragua

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Paying for the environmental services of silvopastoral practices in Nicaragua ☆

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ABSTRACT

Agricultural landscapes can provide many valuable ecosystem services, but many are externalities from the perspective of farmers and so tend to be under-produced. This paper examines an effort to make direct payments for ecosystem services (PES) in an agricultural landscape. The Regional Integrated Silvopastoral Ecosystem Management Project is piloting the use of PES to induce adoption of silvopastoral practices in the Matiguás–Río Blanco area in Nicaragua. Silvopastoral practices could substantially improve service provision while retaining agricultural production, but they have found only limited acceptance among farmers. The Silvopastoral Project seeks to increase their adoption by paying farmers for the expected increase in biodiversity conservation and carbon sequestration services that these practices would provide. The Project developed an 'environmental services index' (ESI) and pays participants for net increases in ESI points. Although the Silvopastoral Project is still underway, it already appears to have succeeded in inducing farmers to increase substantially the use of practices that generate higher levels of ecosystem services. In the project's first two years, over 24% of the total area experienced some form of land use change. The area of degraded pasture fell by two thirds, while pastures with high tree density increased substantially, as did fodder banks and live fences. On-going monitoring indicates that these land use changes are in fact generating the desired services. Questions remain about the long-term sustainability of the approach, however. To ensure sustainability, long-term payments are likely to be needed, raising the question of how they will be financed. Payments by water users and by carbon buyers provide a partial answer to this challenge, but still leave many gaps.

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1. Introduction

Agricultural landscapes can provide many valuable ecosystem services. They can contain high levels of biodiversity, sequester substantial amounts of carbon, and affect downstream water supplies. Many of these services are externalities from the farmers' perspective, however, and so tend to be underproduced. Recent years have seen numerous efforts to devise innovative mechanisms to induce farmers to adopt practices that generate higher levels of services (Landell-Mills and Porras, 2002; Pagiola et al., 2002). An approach that has received increasing attention is to pay farmers directly to provide ecosystem services (Ferraro, 2001; Pagiola and Platais, 2007).

This paper examines one effort to make direct payments for ecosystem services (PES) in an agricultural landscape. The Regional Integrated Silvopastoral Ecosystem Management Project, financed by the Global Environment Facility (GEF), is piloting the use of PES to induce adoption of silvopastoral practices at sites in Nicaragua, Colombia, and Costa Rica (Pagiola et al., 2004). The extensive pastures that replaced the original forests in this area provide particularly low levels of services — with little biodiversity, low carbon sequestration, and adverse impacts on hydrological flows. Silvopastoral practices could substantially improve service provision while retaining agricultural production, but have found only limited acceptance among farmers. The Silvopastoral Project seeks to increase their adoption by paying farmers for the expected increase in biodiversity conservation and carbon sequestration services that these practices would provide.

This paper describes the Silvopastoral Project and its initial results at its Nicaragua site. We begin by describing the benefits of silvopastoral practices and the reasons for their limited adoption. We then discuss the PES approach, and how it is applied in this case. The first two years of the project have already resulted in substantial increases in service provision. Although this project is still underway, it is already generating important lessons for similar efforts.

2. Silvopastoral practices

Cattle production has long been an important cause of the loss of natural habitat and biodiversity in Central America (Downing et al., 1992; Kaimowitz, 1996). In addition to the environmental problems caused by the initial deforestation, extensive grazing often suffers from declining yields, diminishing grass cover, soil erosion, water supply contamination, air pollution, and landscape degradation. Declining producer income results in continuing poverty and can lead to pressure to clear additional areas.

Silvopastoral systems combine fodder plants such as grasses and leguminous herbs with trees and shrubs for animal nutrition and complementary uses. The main silvopastoral systems, either researched or implemented empirically, include planting trees and shrubs in pastures; cut and carry systems, in which livestock is fed with the foliage of specifically planted trees and shrubs ('fodder banks'); using trees and shrubs for fencing; and grazing livestock inside tree plantations. Windbreaks and pastures between tree alleys have been applied to a lesser degree (Murgueitio, 2004).

2.1. *On-site benefits*

Silvopastoral practices, like agroforestry practices, can provide many on-site benefits (Current et al., 1995; Dagang and Nair, 2003). Introducing trees in pasture areas can improve pasture productivity, as trees extract water and nutrients from soil horizons inaccessible to grasses. Trees can also provide direct benefits in the form of products such as fruit, fuelwood, fodder, and timber, while increased shade can enhance livestock productivity, especially for milk production.

2.2. *Biodiversity benefits*

Because of their increased complexity, silvopastoral practices often support much higher levels of biodiversity than traditional pastures (Daily et al., 2003; Dennis et al., 1996; Harvey and Haber, 1999; Horner-Devine et al., 2003; Lindell et al., 2004; Moguel and Toledo, 1999; Ricketts et al., 2001). Silvopastoral practices have been shown to enhance the survival of wildlife species by providing scarce resources and refuge, and to help propagate native forest plants. Food availability for wild birds is high, and the complex structure of the vegetation provides a better nesting substrate and better protection against predators than other agroecosystems. Silvopastoral practices also harbor a larger and more complex assemblage of invertebrates. They can also serve as biological corridors, helping to connect remaining habitats (Saunders and Hobbs, 1991).

2.3. *Carbon sequestration benefits*

Silvopastoral practices can fix significant amounts of carbon in the soil (Pfaff et al., 2000) and in the standing tree biomass (Fisher et al., 1994). Research conducted by CATIE (1999) in Panama and Costa Rica shows that silvopastoral practices can accumulate as much as 13–15 tons carbon (tC) per ha per year, compared to 1–5 tC in extensive pastures. Moreover, silvopastoral practices tend to sequester carbon deeper in the soil profile (40–100 cm depth), thus making it less prone to oxidation and loss (Fisher et al., 1994; Beinroth et al., 1996).

2.4. *Hydrological benefits*

Silvopastoral practices can also affect water services, though the effect is variable and not always as clear-cut as often supposed (Bruijnzeel, 2004). Trees generally increase infiltration, thus reducing surface runoff and soil erosion, but have higher evapotranspiration, thus tending to decrease water yield. In hilly areas, trees can also help prevent landslides by anchoring soils, particularly if a variety of species with different root depths are used.

3. Barriers to adoption

Despite their many benefits, silvopastoral practices have seen limited adoption (Dagang and Nair, 2003). Large areas remain under extensive pasture with minimal tree cover.

The low profitability of silvopastoral practices from the farmers' perspective is an important constraint to their adoption. Establishment costs in Matiguás–Río Blanco range from US$180/ha for sowing improved pasture to about US$400/ha for planting trees at high density in pastures. Establishing fodder banks costs US$170–300/ha, depending on the species. Live fences cost US$110–160/km. Increasing or improving herds to take advantage of increased fodder production entails additional costs. There are also opportunity costs resulting from the time lags before the systems become productive, particularly in systems with substantial tree components. Rates of return to adopting silvopastoral practices thus tend to be low. Estimates prepared for the Silvopastoral Project show rates of return of 4–14% (Gobbi, 2002), while White et al. (2001) found rates of return of 9–12% to adopting improved pasture in Esparza, Costa Rica. These estimates only consider the on-site benefits of silvopastoral practices.

Even if silvopastoral practices are financially viable, high initial investment costs can pose problems for credit-constrained farmers. Credit has been found to increase adoption of agroforestry practices, and its role is very often significant (Pattanayak et al., 2003).

The complexity of some silvopastoral practices means that technical assistance (TA) may help farmers adopt them. Access to extension significantly affected agroforestry adoption in 90% of studies that included it (Pattanayak et al., 2003, including two studies in Costa Rica (Thacher et al., 1997; Zbinden and Lee, 2005).

The long-term nature of investments in most silvopastoral practices often makes tenure security an important factor in their adoption (Meinzen-Dick et al., 2002). Tenure variables were significant in 72% of agroforestry adoption studies that included them (Pattanayak et al., 2003).

Many of these barriers may be more salient for poorer households, who are less likely to have secure tenure, tend to have fewer savings and less access to credit, and are less likely to receive TA (de Janvry and Sadoulet, 2000; López and Valdés, 2000).

4. Payments for environmental services

PES is a market-based approach to conservation based on the twin principles that those who benefit from environmental services (such as users of clean water) should pay for them, and that those who generate services should be compensated for providing them (Wunder, 2005; Pagiola and Platais, 2007). The approach seeks to create mechanisms to arrange transactions between service users and providers that are in both parties' interests, thus internalizing what would otherwise be an externality. In a PES mechanism, service providers receive payments conditional on their providing the desired environmental services (or adopting a land use thought to generate those services). Participation is voluntary.

The PES approach is attractive in that it (i) generates new financing, which would not otherwise be available for conservation; (ii) is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of government or donor funding; and (iii) is likely to be efficient, in that it conserves services whose benefits exceed the cost of providing them, and does not conserve services when the opposite is true (Pagiola and Platais, 2007).

There has been considerable experimentation with PES and other market-based approaches in developing countries in recent years (Pagiola and Platais, 2007; Pagiola et al., 2002; Landell-Mills and Porras, 2002). Latin America has been particularly receptive to the approach, with PES programs in operation in Colombia (Echevarría, 2002), Costa Rica (Pagiola, 2005), Ecuador (Albán and Wunder, 2005), El Salvador (Díaz et al., 2002), and Mexico (Muñoz et al., 2006), at various scales, and under preparation or study in other countries.

Most PES programs focus on forests, but several have begun using the approach in agricultural landscapes. In Mexico, the Scolel Té project pays farmers to provide carbon sequestration services by undertaking agroforestry practices (Tipper, 2002). Costa Rica's PES program added an agroforestry contract in 2004 (Pagiola, 2005).

5. Implementing PES in Matiguás–Río Blanco, Nicaragua

The Silvopastoral Project is piloting the use of PES to generate biodiversity conservation and carbon sequestration by encouraging the adoption of silvopastoral practices in degraded pastures in three areas: Quindío, in Colombia; Esparza, in Costa Rica; and Matiguás–Río Blanco, in Nicaragua (Pagiola et al., 2004). The project is financed by a US$4.5 million GEF grant with the World Bank as the implementing agency. It is being implemented in the field by local non-governmental organizations (NGOs). In Nicaragua, it is being implemented by Nitlapan, an NGO affiliated with the Central American University.

5.1. *Project site*

Matiguás–Río Blanco is located in the department of Matagalpa, about 140 km northeast of Managua, on the southern slopes of the Cordillera de Darien. It has an undulating terrain, with an elevation of 300–500 m above sea level. Average temperature is about 25 °C and average annual rainfall 1700–2500 mm. Participants are clustered in the Bulbul and Paiwas microwatersheds.

Prior to project implementation, extensive grazing dominated land use, with pastures covering about 63% of the area (Table 1).[1] Of this, about half was degraded pasture, and another quarter had few or no trees. Silvopastoral practices, though not unknown, were not widely used: pastures with high tree density covered 17% of the area, and fodder banks 3%. About 20% of total area remained under forest, mostly as riparian forest.

The average participating household is composed of six members, and has about 31 ha of land and about 30 head of

[1] In the discussion below, all figures refer only to the area managed by project participants, which accounts for about 60% and 40% of total area in the Bulbul and Paiwas microwatersheds, respectively. All data for which no explicit reference is given are from Silvopastoral Project files. Wherever possible, we have supplied references to published reports.

Table 1 – Land use among Silvopastoral Project participants, Matiguás–Río Blanco, Nicaragua, 2003–2005

Land Use	2003		2004		2005	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Infrastructure, housing, and roads	5.5	0.2	5.5	0.2	7.6	0.2
Annual crops	231.5	7.4	161.0	5.1	111.0	3.5
Degraded pasture	868.9	27.7	401.5	12.8	281.3	8.9
Natural pasture without trees	65.0	2.1	84.5	2.7	67.8	2.1
Improved pasture without trees	22.4	0.7	38.3	1.2	35.6	1.1
Semi-permanent crops	33.0	1.1	27.4	0.9	25.3	0.8
Natural pasture with low tree density	333.7	10.6	448.0	14.3	350.3	11.1
Fodder bank [a]	88.3	2.8	154.1	4.9	192.4	6.1
Improved pasture with low tree density	137.3	4.4	250.7	8.0	260.1	8.2
Natural pasture with high tree density [b]	381.8	12.2	471.3	15.0	507.4	16.0
Diversified fruit crops [a]	21.1	0.7	20.1	0.6	23.6	0.7
Monoculture timber plantation	1.1	0.0	2.1	0.1	3.9	0.1
Improved pasture with high tree density [b]	167.0	5.3	278.8	8.9	465.2	14.7
Scrub habitats (*tacotales*)	154.9	4.9	157.5	5.0	177.5	5.6
Secondary and riparian forest [a]	627.9	20.0	638.6	20.3	656.6	20.7
Total area	3139.4	100.0	3139.4	100.0	3165.5	100.0
Live fence (km)	128.5		239.0		332.3	

Notes: Totals may not add up because of rounding; increase in total area in 2005 due to some farmers buying land.
Land uses recognized by the project but not found at this site are omitted.
Sources: Silvopastoral Project data, based on analysis of remote sensing imagery verified in the field.
[a] Similar land uses with small areas have been aggregated.
[b] The project distinguishes land uses with recently planted trees from the same land uses with mature trees for the purpose of computing the ESI score; here these land uses have been aggregated to their mature state.

livestock. Agriculture is the main economic activity, with few households having off-farm income. The average per capita income of about US$340 is below the poverty line. Few households have water or electricity, and education levels are very low. Although most households occupy public land, long-term occupancy gives them secure tenure.

5.2. *Source of financing*

In pure PES programs, service users pay for service provision, thus creating a market-like transaction between service users and providers (Pagiola and Platais, 2007). In the Silvopastoral Project, the services being sought are biodiversity conservation and carbon sequestration. As the ultimate 'users' of these global benefits are very diffuse, the transaction costs of charging them directly would be prohibitive, so funding is provided by the GEF.[2] The GEF was established by the global community to preserve global benefits, so its financing can be considered a payment by the users' representative. Payments are made for benefits which GEF considers important, based on guidance from the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).

Although silvopastoral practices can also generate water services, no payments from water users were included in the Project. As discussed below, it is hoped that water payments may be implemented in the future.

5.3. *Service providers*

The Silvopastoral Project, like most developing country PES programs, chooses providers based on geographic criteria: landowners in specified areas can participate, while those outside cannot. The Matiguás–Río Blanco site was selected based on its location in a biological corridor.[3] Within the site, all households meeting minimal criteria of herd size were eligible to participate. Budget constraints limited participation to slightly over 100 households. Households were enrolled on a first-come, first-served basis until this limit was reached. Many non-participating households wanted to participate.

5.4. *Service delivery*

Ideally, PES programs would pay for actual service delivery. This is generally impractical, however. The services sought often cannot be observed by landowners, and so they cannot easily manage their land to produce them. Most PES programs thus pay for the adoption (or retention) of land uses that are thought to generate the desired services. The Silvopastoral Project follows this approach.

Most PES programs focus on very few land uses. Costa Rica's and Mexico's PES programs, for example, focus primarily on forest conservation (Pagiola, 2005; Muñoz et al., 2006). This approach has the virtue of simplicity, but fails to recognize the broad spectrum of possible effects. Pastures with low tree density provide fewer biodiversity and carbon benefits than pastures with higher tree density. Likewise, biodiversity benefits increase when a variety of native species with different canopy heights is used.

To provide payments that are closely correlated to levels of service provision, the Silvopastoral Project developed indices of biodiversity conservation and carbon sequestration under different land uses, then aggregated them into a single 'environmental services index' (ESI). This approach is similar to the Environmental Benefits Index (EBI) used in the US Conservation Reserve Program (CRP) (NCEE, 2001). The ESI

[2] Rules for land use-based carbon sequestration activities under the Kyoto Protocol's Clean Development Mechanism were not yet in place when the Silvopastoral Project was prepared.

[3] Location is irrelevant to carbon sequestration, so biodiversity conservation objectives alone were considered in selecting sites. To produce Kyoto-compliant emissions reductions, however, it would have been necessary to demonstrate that project sites had been deforested prior to 1990.

distinguishes 28 different land uses, though not all are found at Matiguás–Río Blanco (Table 2). The biodiversity conservation index was scaled with the most biodiversity-poor land uses (degraded pasture and annual crops) set at 0.0 and the most biodiversity-rich land use (primary forest) set at 1.0. Within this range, a panel of experts assigned points to each land use, taking into consideration factors such as the number of species, their spatial arrangement, stratification, plot size, and fruit production. Similarly, the carbon sequestration index assigns points to different land uses according to their capacity to sequester stable carbon in the soil and in hard wood. The index is scaled so that 1 point equals about 10 tC/ha/year. As payments in this case come solely from the GEF, only global benefits were included in the ESI.

5.5. *Payment contracts*

Participating landowners enter into contracts under which they receive annual payments, over a four-year period, based on their net increase in ESI points (computed over the entire farm) relative to the baseline for their farm. Payments are made after land use changes have been monitored in the field. Thus the project differs substantially from earlier approaches that relied primarily on subsidizing the cost of adopting the desired practices. In contrast, Silvopastoral Project payments are proportional to the level of services provided (as measured by changes in the ESI), irrespective of the cost of providing them.

As with all other developing country PES programs, the Silvopastoral Project offers fixed payments for eligible land uses. A procurement auction, as employed for example in the CRP, might have reduced costs by allowing the lowest-cost providers to be identified (Ferraro, 2005). However, this approach was deemed too complex for the setting.

Unlike many PES programs, payments under the Silvopastoral Program are explicitly short-term. Silvopastoral practices tend to be unattractive to farmers, despite their long-term benefits, primarily because of their substantial initial investment and the time lag between investment and returns. This led to the hypothesis that a relatively small payment provided early on could 'tip the balance' of profitability between current and silvopastoral practices, by increasing the net present value of investments in silvopastoral practices and by reducing the initial period in which these practices impose net costs on farmers. The payments also alleviate the liquidity problems faced by many farmers and help them finance the required investments.

5.6. *Payment levels*

In principle, payments should be no less than the difference in returns compared to the landowners' best alternative land use (or they will not participate), and no more than the value of the benefit provided (or it would not be worthwhile to provide the service). In practice, the value of services is extremely difficult to estimate, particularly for biodiversity conservation. In contrast, opportunity costs can usually be estimated relatively easily. For this reason, and to limit budgetary requirements, all existing PES programs implicitly or explicitly base payments

Table 2 – Environmental service indices used in the Silvopastoral Project (points per hectare, unless otherwise specified)

Land use	Biodiversity index	Carbon sequestration index	Environmental services Index (ESI)
Annual crops	0.0	0.0	0.0
Degraded pasture	0.0	0.0	0.0
Natural pasture without trees	0.1	0.1	0.2
Improved pasture without trees	0.4	0.1	0.5
Semi-permanent crops (plantain, sun coffee)	0.3	0.2	0.5
Natural pasture with low tree density (<30/ha)	0.3	0.3	0.6
Natural pasture with recently-planted trees (>200/ha)	0.3	0.3	0.6
Improved pasture with recently-planted trees (>200/ha)	0.3	0.4	0.7
Monoculture fruit crops	0.3	0.4	0.7
Fodder bank	0.3	0.5	0.8
Improved pasture with low tree density (<30/ha)	0.3	0.6	0.9
Fodder bank with woody species	0.4	0.5	0.9
Natural pasture with high tree density (>30/ha)	0.5	0.5	1.0
Diversified fruit crops	0.6	0.5	1.1
Diversified fodder bank	0.6	0.6	1.2
Monoculture timber plantation	0.4	0.8	1.2
Improved pasture with high tree density (>30/ha)	0.6	0.7	1.3
Diversified timber plantation	0.7	0.7	1.4
Scrub habitats (*tacotales*)	0.6	0.8	1.4
Riparian forest	0.8	0.7	1.5
Disturbed secondary forest (>10 m^2 basal area)	0.8	0.9	1.7
Secondary forest (>10 m^2 basal area)	0.9	1.0	1.9
Primary forest	1.0	1.0	2.0
New live fence or established live fence with frequent pruning (per km)	0.3	0.3	0.6
Wind break (per km)	0.6	0.5	1.1

Notes: The ESI is the sum of the biodiversity and carbon sequestration indices.
Land uses recognized by the project but not found at this site are omitted.

on the opportunity costs of the main alternative land uses. The Silvopastoral Project's 'tip the balance' approach follows this approach. Based on analyses of the relative profitability of different practices, payment levels were set at US$75 per incremental ESI point, per year.

These payments were compared to payment levels for similar services elsewhere to ensure they were reasonable. In terms of carbon emissions reductions, the US$75/point/year payment is equivalent to paying US$7.5/tC. This compares favorably to world prices at the time of project launch of US $14–20/tC (World Bank, 2004). Similar comparisons for biodiversity conservation are difficult. The highest possible payment, for converting degraded pasture to forest (an increase of 2.0 ESI points), would be US$75/ha/year, assuming that half the payment is for biodiversity conservation, or a total of US $300/ha over four years. At a 10% discount rate, this is equivalent to a long-term annual payment of about US$30/ha/year. In comparison, Costa Rica's PES Program paid US$42/ha/year and Mexico's program paid US$36/ha/year for cloud forests and US$27/ha/year for other forests (Pagiola, 2005; Muñoz et al., 2006). In fact, the implicit price of biodiversity conservation under the Silvopastoral Project is effectively even lower, as it is only paid for incremental conservation. In contrast, neither Costa Rica nor Mexico require incremental actions, and recent studies suggest that their actual impact on land use has been limited (Sills et al., 2006).

5.7. *Avoiding leakage and perverse incentives*

That environmentally damaging activities will only be displaced rather than curtailed is a common concern in PES programs. The Silvopastoral Project avoids the problem by computing changes in ESI over the entire farm — any switch to land uses that reduce service provision would thus incur negative points, reducing the total payment. Induced leakage outside participating farms through price effects are unlikely at this stage due to the very small size of the project area, but may become a concern if the approach were to be expanded.

Initially, land users were to be paid only for the increase in ESI points over the pre-project score. It soon became clear that this would create perverse incentives. "Bueno, corto todo," was a common reaction by landowners when told they would not be compensated for existing trees: "fine, I'll cut them all." As a result, the initial plan was modified to include a one-time payment of US$10/point for baseline points. Coming before implementation began, this payment may have been particularly helpful in alleviating financing constraints.

6. Results

The Silvopastoral Project made its first payments, for baseline ESI points, in July 2003. After monitoring land use changes, it made its first payment for increases in ESI scores in May 2004, and a second payment in May 2005. Additional payments will be made in 2006 and 2007.

Three data sets are available to study the impact of PES in Matiguás–Río Blanco. A baseline survey conducted in late 2002, during project preparation, collected detailed information on household characteristics. A second survey, conducted in March–May 2004, collected information on land use changes in the first year of implementation.[4] Finally, detailed land use maps are prepared annually for each farm using remote sensing imagery.[5] These mapping data give accurate and consistent measures of area and ensure that land uses are classified consistently into the project's categories.

All three data sets include a control group of non-participants. The main intended purpose of this group was to distinguish project-induced land use changes from changes induced by other factors, as recommended in emerging guidelines for conservation project evaluation (Ferraro and Pattanayak, 2006).[6] Upon analysis, however, control group members were found to have been poorly chosen, differing from participants in many important characteristics (such as income, farm size, and herd size). Because of these differences, we decided that using the control group would not be useful. Our analysis, therefore, focuses entirely on participants.

6.1. *Land use changes*

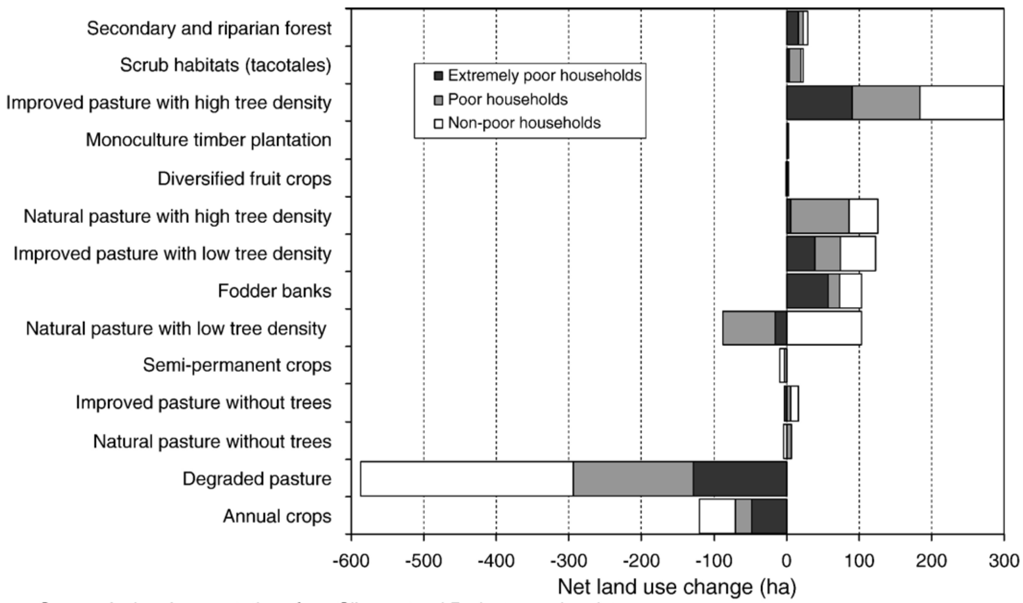
Table 1 and Fig. 1 show that participants made substantial land use changes during the Project's first two years, affecting over 24% of total area. Changes ranged from minor changes such as sowing improved grasses in degraded pastures to very substantial changes such as planting high-density tree stands or establishing fodder banks. The area of degraded pasture was reduced by 68%, and that of annual crops by 52%. Pastures with low tree density experienced a net increase of 19%, and pastures with high tree density of 23%. The area devoted to fodder banks more than doubled, and the length of live fences increased by 160%. Moreover, these net figures understate the changes. Some existing pastures with low tree densities were upgraded to higher tree densities, for example. More traditional silvicultural practices such as timber plantations or fruit orchards found little favor, with farmers preferring to plant timber and fruit trees in pastures and along fencelines.

Land use changes were more extensive in the first year: 467 ha of degraded pasture were converted to other uses, compared to 121 ha in the second year. Because the project only pays for four years, participants have an incentive to undertake land use changes as early as possible. The second year did see a greater expansion of the more complex land uses. Over half the net increase in the area of pastures with high tree density occurred in the second year, for example.

[4] The questionnaires for both surveys are available from the authors on request.

[5] Quickbird imagery with a 61 cm resolution was used to prepare detailed land use maps for each farm, which were then extensively ground-truthed to match each plot to one of the ESI's 28 land uses.

[6] Assigning applicants randomly to either the participant or the control group, as recommended by Ferraro and Pattanayak (2006), was judged to be infeasible because of strong household desire to participate. Accordingly, a matching approach was adopted (as also recommended by Ferraro and Pattanayak), with control group households selected from nearby communities in similar areas. Even there, Nitlapan encountered substantial animosity among control group members who demanded to be full participants and resisted providing the access and cooperation needed for proper monitoring.



Source: Authors' computations from Silvopastoral Project mapping data.

Fig. 1 – Land use changes by Silvopastoral Project participants, by income group, Matiguás–Río Blanco, Nicaragua, 2003–2005.

The lack of a proper control group prevents a formal comparison to land use changes elsewhere, but casual observation suggests that land use changes in nearby areas were substantially less extensive, in both area affected and degree of change. It is certainly possible that some of the changes observed would have occurred even without the project, but it is unlikely that all would have. A more critical question, as discussed below, is whether the changes are sustainable.

The extent of land use change is surprising given the cost of the required investments. Data from the first-year participant survey show that animal sales (61% of households) and the project's initial 'baseline' payment (53%) were the main funding sources, followed by savings (41%) and credit from a local community bank (32%). Some changes were undertaken entirely with family labor and did not require financing. These results indicate that even poor households like those in Matiguás–Río Blanco often have many ways to finance profitable investments. Nevertheless, providing some initial financing, such as the baseline payment made by the Silvopastoral Project, or frontloading payments, as the reforestation contract in Costa Rica's PES program does (Pagiola, 2005), may be desirable.

To test the importance of TA, participants are divided into two groups. While most participants receive both payments and TA, a randomly selected subgroup of 30 households do not receive TA. A test of factors affecting the adoption of silvopastoral practices in the project's first year found TA not to be significant (Pagiola et al., 2007). As shown in Table 1, silvopastoral practices were already known in the region. Even the more complex practices, such as fodder banks, were already in use, albeit on a small scale. Many households thus already knew how to implement them, reducing the importance of TA. TA may, however, help farmers choose more appropriate practices and implement them better. It is too early to assess whether this is the case in Matiguás–Río Blanco.

6.2. *Impacts on environmental services*

The total ESI score of participants increased by 42% (Table 3). To verify that the desired ecosystem services are actually being generated, biodiversity and carbon sequestration are

Table 3 – Environmental service generation by Silvopastoral Project participants, Matiguás–Río Blanco, Nicaragua, 2003–2005

(ESI points)

Land use	2003	2004	2005
Infrastructure, housing, and roads	0.0	0.0	0.0
Annual crops	0.0	0.0	0.0
Degraded pasture	0.0	0.0	0.0
Natural pasture without trees	13.0	16.9	13.6
Improved pasture without trees	11.2	19.2	17.8
Semi-permanent crops	16.5	13.7	12.7
Natural pasture with low tree density	200.2	268.8	210.2
Fodder bank [a]	75.8	138.0	186.6
Improved pasture with low tree density	123.5	225.7	234.1
Natural pasture with high tree density [b]	378.6	454.4	484.5
Diversified fruit crops [a]	21.0	19.1	19.1
Monoculture timber plantation	1.3	2.5	2.5
Improved pasture with high tree density [b]	210.5	347.5	570.5
Scrub habitats (*tacotales*)	216.8	220.5	248.5
Secondary and riparian forest [a]	966.9	986.4	1019.3
Live fence	77.2	169.7	267.4
Total	2312.7	2882.3	3286.6

Sources: Silvopastoral Project data, based on analysis of remote sensing imagery verified in the field.
[a] Similar land uses with small areas have been aggregated.
[b] The project distinguishes land uses with recently planted trees from the same land uses with mature trees for the purpose of computing the ESI score; here these land uses have been aggregated to their mature state but ESI points reflect their current condition.

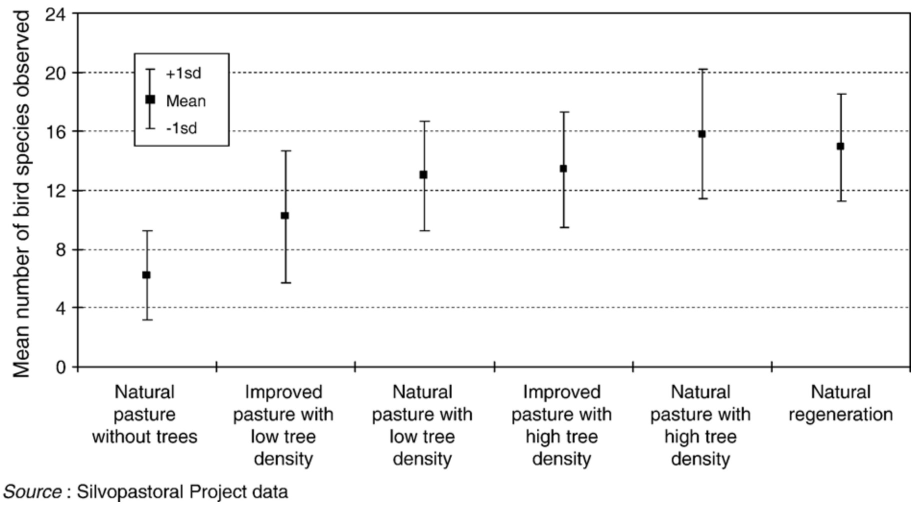


Fig. 2 – Bird species richness of different land use systems in Matiguás–Río Blanco, Nicaragua.

being monitored in all land uses. In this regard, the Silvopastoral Project differs from most other PES programs, who have generally been content to assume that the land uses they support are generating the desired services.

For biodiversity, counts of bird species are the main indicator, complemented by studies of butterflies, ants, and mollusks. Factors such as endemicity and rarity are taken into consideration.[7] Initial plot-level results are very promising (Pérez et al., 2006). Fig. 2 illustrates one of the indicators of alpha diversity collected (diversity within a particular area, see Whittaker, 1972), the number of bird species. Other indicators show broadly similar results. Landscape-level results (beta diversity) are still pending, but here too initial results are promising. A total of 151 different bird species were observed in project-supported land uses, including 29 species considered endangered under Central American Development Committee (CCAD) criteria. 39% of species observed were highly forest dependent and another 35% of medium-high forest dependence.

Monitoring of carbon sequestration is still underway; it will take time to determine the extent to which silvopastoral practices sequester carbon in deep soil.

Funding constraints prevented monitoring of water quality at Matiguás–Río Blanco. Water impacts could only be monitored at the project's Colombia site. Results there show a rapid drop in turbidity, biological oxygen demand (BOD), and coliform counts when riverbanks are reforested and protected from livestock entry, as well as the return of invertebrates indicative of unpolluted water (Chará et al., 2006).

[7] Biodiversity monitoring methodologies were developed with the assistance of the American Bird Conservancy and are described by Pérez et al. (2006). A baseline survey of bird species was undertaken prior to project start; and samples of plots are re-surveyed every year.

6.3. *Impact on the poor*

Although PES can contribute to poverty reduction by making payments to poor farmers, there has been concern over the ability of poorer households to participate (Landell-Mills and Porras, 2002; Pagiola et al., 2005). Matiguás–Río Blanco provides a strong test of poorer households' ability to participate. Unlike most PES programs, the Silvopastoral Project requires investments to be undertaken by participants, some of them complex and onerous.

An earlier analysis showed substantial participation by poorer households during the Project's first year (Pagiola et al., in press), a pattern which continued in the second year. As shown in Fig. 1, poor and extremely poor households accounted for a substantial share of land use changes, including 50% of the decline in degraded pasture and 58% of the decline in annual crops. Moreover, land use changes by poorer households were not limited to adopting technically simpler and cheaper practices. Poorer households established 71% of fodder banks and 64% of pastures with high tree density. Indeed, it was the non-poor who focused on the simpler practices, such as establishing natural pasture with low tree density.

It is too soon to judge whether the Silvopastoral Project will have a significant and lasting impact on the welfare of participating farmers. This will largely depend on the sustainability of the project-supported practices (see discussion below). If these practices, once established, are indeed more profitable for farmers than current practices, then payments will have helped farmers move to a higher income path. Conversely, if the new practices are not profitable enough to be retained once payments end, then the impact of payments on welfare will likewise prove fleeting.

6.4. *Transaction costs*

Transaction costs play a critical role in the cost-effectiveness, sustainability, and replicability of PES mechanisms (Pagiola and Platais, 2007), and in the extent to which poorer farmers can participate (Pagiola et al., 2005). Because of its pilot nature, the Silvopastoral Project has relatively high costs for detailed monitoring and other activities that would not necessarily be needed in a scaled-up project. The ESI allows payments to be closely tied to expected benefits, but also imposes relatively high monitoring costs. To reduce these costs, the project is testing proxy indicators that are highly correlated with biodiversity conservation but are easy and cheap to monitor, ideally using remote sensing. A crucial question that is being explored concerns the tradeoff between the precision of the index and the transaction costs involved in implementing it.

7. Sustainability and replicability

Initial results from the project suggest that PES can induce land use change, and that silvopastoral practices can generate environmental services. But are these changes sustainable? And can the approach be extended to other areas?

7.1. *Are short-term payments sufficient?*

Payments in a PES program should generally be on-going rather than finite (Pagiola and Platais, 2007). The logic for this is simple: if environmental services are externalities, they will only be generated as long as payments are received. Indeed, previous approaches that relied on short-term payments have often resulted in farmers reverting to previous land uses once payments ended (Lutz et al., 1994).

The Silvopastoral Project departed from this logic based on the hypothesis that silvopastoral practices, once established, were privately more profitable than current practices, and so would be retained. If this hypothesis is correct, the short-term payments offered by the project will be sufficient to induce a sustainable change in land use.[8]

It is too soon to judge the profitability of silvopastoral practices for participants, as many practices are still being implemented. Several indicators suggest they may well be: milk production in participating farms has increased from 3.4 to 3.7 l/cow in winter and from 3.2 to 3.4 l/cow in summer, and stocking rates have increased from 1.5 to 2.0 livestock units/ha. Livestock mortality in the summer (when it tended to be high due to limited fodder availability) has declined.

To try to determine the long-term sustainability of the project's PES mechanism, a randomly-selected sub-group of participants was given a modified contract: rather than being paid over a four-year period, they received a similar amount over a two-year period. The early results of this test are not encouraging: at least two participants with 2-year contracts cut back some of the trees they had planted soon after they had received their second and final payment.

In general, farmers can be divided into three groups: (1) farmers for whom silvopastoral practices are sufficiently profitable to justify adoption with no additional inducement; (2) farmers for whom silvopastoral practices are profitable once established, but for whom initial costs make adoption unattractive; and (3) farmers for whom silvopastoral practices are not profitable, even once established.[9] Only for farmers in group 2 would short-term payments be sufficient to sustainably 'tip the balance'. Farmers in group 3 may adopt the practices while receiving payments, but would abandon them once payments cease. Farmers in group 1 would adopt the practices even without payments, so PES would not change their behavior; at best, it might accelerate changes that would have occurred anyway.

How large the middle group is remains to be determined, in Matiguás–Río Blanco itself and more generally. Overall, it is highly unlikely that the profitability of silvopastoral practices in a country as large and varied as Nicaragua, let alone region-wide, is always such that a short-term payment would 'tip the balance' in their favor. Thus, while there may well be some cases in which short-term payments are sufficient, long-term payments will often be necessary to induce many farmers to sustainably change their land use choices in ways that provide more ecosystem services.[10] Even in the case of farmers for whom short-term payments are sufficient to induce long-term adoption of silvopastoral practices, longer-term payments may still be desirable because of the conditionality they allow on other land use decisions, such as preventing burning fields or cutting trees in other parts of the farm. Cases in which short-term payments are sufficient are thus likely to be the exception rather than the rule. This has important implications for the financing needs of PES programs.

7.2. *Who will pay?*

If long-term payments are needed to generate ecosystem services, long-term financing is needed. The PES approach proposes to secure such financing from service users.[11]

[8] Short-term payments of this nature are not uncommon in developing country PES programs. Costa Rica's reforestation contract pays for five years but expects the resulting plantations to be maintained for up to 20 years (Pagiola, 2005), while the PROFAFOR reforestation program in Ecuador pays for three years but expects forests to be retained for 99 years (Albán and Wunder, 2005). In both of these cases, as in the Silvopastoral Program, timber and other products are expected to make plantations profitable once payments cease. Mexico's PES program also has de facto short-term payments as its five-year contracts are not renewable (Muñoz et al., 2006). In this case, the motivation was political: to spread payments as widely as possible. As in the Silvopastoral Project, sustainability is a concern in each of these cases.

[9] In fact, the relative profitability of silvopastoral practices may well differ from field to field, so it would be more correct to say that some fields are in group 1, while other fields (perhaps including some belonging to the same farmer) are in groups 2 or 3.

[10] Conversely, another group would require no payments at all. Distinguishing such farmers from those who do remains a major challenge.

[11] In addition to generating the required financing, making users pay has the desirable characteristic that financing embodies information about what the users find valuable, and the magnitude of this value (Pagiola and Platais, 2007). When PES programs are financed from government budgets, their efficiency depends on the degree to which governments are able to identify valuable services. Moreover, even when governments do undertake careful prior analyses to do so, political considerations may overwhelm technical ones, as occurred in Mexico's PES program (Muñoz et al., 2006).

Making users pay for ecosystem services is difficult, however, when the services of interest bring global benefits, as in the case of the biodiversity conservation and carbon sequestration benefits provided by silvopastoral practices.

The carbon sequestration services provided by establishing silvopastoral practices could, in principle, be sold to carbon buyers under the Clean Development Mechanism (CDM), which would provide payments over a reasonably long period. The initial results of the Silvopastoral Project suggest that carbon financing could be a viable source of funding, even if it had to bear the whole burden of payments. The project has demonstrated that a US$75/point/year payment induces substantial land use change. If such a payment were solely for carbon sequestration, it would correspond to US$15/tC — quite compatible with observed prices of US$14–20/tC (World Bank, 2004), as long as transaction costs are kept low. Several projects that plant trees in agricultural landscapes are being submitted to the CDM (Bosquet and François, 2006). The scope for such projects is limited, however, by overall limits on the emission reduction credits that can be generated by land use-based activities. Funding for carbon sequestration might also be sought from the voluntary (or 'retail') market. The Scolel Té project, for example, is financed by sales to the voluntary market (Tipper, 2002). This market is more flexible than the CDM market, but is also smaller and tends to pay less. Its mean price of US$5/tC (World Bank, 2004) implies a payment of US$25/point, which would likely induce much less land use change than occurred at Matiguás–Río Blanco.

Water services offer the most promising avenue for financing long-term PES programs, as water users are easy to identify; receive clear, well-defined benefits; and often already have financing mechanisms (Pagiola and Platais, 2007). However, demand for water services tends to be very site-specific (Pagiola et al., 2007). The site-specificity of water services is illustrated in the project area. Both Matiguás and Río Blanco face a variety of problems because of degradation in the watersheds from which they draw their water. Neither the Bulbul nor the Paiwas microwatersheds contributes to their water supply, however, and so neither would be eligible for any payments these municipalities might make.

In cases where neither carbon payments nor water payments are possible (or sufficient) but there is a need to improve biodiversity conservation in agricultural landscapes, options are limited. Available biodiversity-specific financing sources, such as the GEF and environmental NGOs, tend to have limited funding and to only provide short-term funding. Bioprospecting was once thought to be a promising source for long-term financing, but has proven disappointing in practice. Tourism may provide another source of financing for biodiversity conservation, in some instances, but so far no PES program has succeeded in tapping it.[12] Another option is to place short-term financing from GEF or other donors in an endowment fund, thus converting it into a long-term payment stream. This approach is being pursued in PES projects supported by the World Bank and GEF in Costa Rica and Mexico. The Worldwide Fund for Nature (WWF) has also established such an endowment fund to help protect the Monarch Butterfly (*Danaus plexippus*) wintering grounds in Mexico.

8. Conclusions

Because most ecosystem services are externalities from the farmers' perspective, they tend to be underproduced. PES approaches such as that being piloted in Matiguás–Río Blanco have considerable potential for helping to increase the generation of ecosystem services in agricultural landscapes. Although the Silvopastoral Project is still underway, it already appears to have succeeded in inducing farmers to increase substantially the use of practices that generate higher levels of ecosystem services, and on-going monitoring indicates that these land use changes are in fact generating the desired environmental services.

Ensuring that these changes are sustainable is challenging, however. Short-term payments such as those offered by the Silvopastoral Project may sometimes be sufficient to 'tip the balance' towards adoption of the desired land use changes, but in most cases longer-term payments are likely to be required. This creates the challenge of finding suitable long-term funding sources to make such payments. The best opportunities for developing such long-term funding are likely to be found when the services being provided are private goods (as in the case of water), or where regulations create a market for public goods (as in the case of carbon, thanks to the Kyoto Protocol and regulations in some individual countries). Where these conditions do not hold, as is largely true for biodiversity services, use of PES will be much more difficult. Of course, other approaches to these vexing problems also suffer from their own limitations. In most cases, it is likely that a range of approaches will be needed. PES promises to be a useful and powerful new tool, but it is not a silver bullet.

In addition to making payments appropriately, PES programs may need to ensure that other barriers to adoption of practices that generate environmental services are addressed. These may include insecure tenure, lack of credit, or lack of knowledge of the new practices. Initial results in Matiguás–Río Blanco suggest that such barriers are not always as insuperable as they are sometimes made out to be, even for poor households. Nevertheless, addressing such problems, where they exist, may be important to the success of PES programs.

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[12] A PES project in Mexico supported by the World Bank and GEF will attempt to secure payments from the tourism industry (Pagiola and Platais, 2007).

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