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Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia

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ABSTRACT

Marketing several environmental services from a single area can help access diverse sources of funding and make conservation a more competitive land use. In Bolivia's Los Negros valley (Department of Santa Cruz), bordering the Amboró National Park, 46 farmers are currently paid to protect 2774 ha of a watershed containing the threatened cloud-forest habitat of 11 species of migratory birds. In this payment for environmental services (PES) scheme, annual contracts prohibit tree cutting, hunting and forest clearing on enrolled lands. Farmer–landowners as service providers submit to independent yearly monitoring, and are sanctioned for non-compliance. Facilitated by a local NGO, Fundación Natura Bolivia, one service buyer is an international conservation donor (the US Fish and Wildlife Service) interested in biodiversity conservation. The second service users are downstream irrigators who likely benefit from stabilized dry-season water flows if upstream cloud forests are successfully protected. Individual irrigators have been reluctant to pay, but the Los Negros municipal government has on their behalf contributed ~US$4500 to the scheme. The negotiated payment mode is annual *quid pro quo* in-kind compensations in return for forest protection. Predominantly, payments are made as "contingent project implementation", transferring beehives supplemented by apicultural training. With regard to service provision, environment committees and education programs have increased awareness in downstream communities of the probable water-supply reduction effect of continued upstream deforestation. External donors have funded subsequent studies providing basic economic, hydrological and biodiversity data, and covered PES start-up (~US$40,000) and running transaction costs (~US$3000 per year over the last three years). The greatest challenges in the development of the PES mechanism have been the slow process of building trust between service buyers and providers, and in achieving clear service-provision additionality.

1. Introduction

Despite numerous attempts at integrated watershed management in Bolivia, there have been few successes (Durán, 2005). Watershed projects have invariably focused on managing supply through construction of dams and infrastructure. Although Bolivia has ample water per-capita availability, with current demand at only ~1% of total supply, localized water scarcity continues to breed conflicts. Irrigated agriculture accounts for 80% of demand, yet irrigators pay low or zero water tariffs, so water wastage and distribution inefficiencies are widespread (Durán, 2005; Wunder and Vargas, 2005; Asquith and Vargas, 2007).

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Water scarcity is thus becoming a major agricultural production constraint throughout upland Bolivia. Farmers in the town of Los Negros in the mesothermic valleys bioregion claim that dry-season water flows have halved in the last 25 years (Rojas-Peña, pers. comm., 2004). Although downstream landowners blame upland deforestation, the growing scarcity is probably a combined result of factors reducing water supply (such as land-use changes), higher water off-take from irrigators upstream (due to increased population and more intense cropping), and losses during water distribution.

A potential new form of watershed management is payments for environmental services (PES), a voluntary, contingent transaction around a well-defined environmental service (or a service-producing land use) between at least one buyer and one seller (Wunder, 2005). In the Los Negros valley, a recently initiated PES scheme involves the simultaneous purchase of two environmental services. The US Fish and Wildlife Service is paying for the protection of habitat for migratory bird species, while downstream irrigators through the Municipality of Pampagrande are paying to conserve the same upland forest and puna (native central Andean alpine grassland) vegetation that likely helps maintain dry-season water supplies. The service buyers are jointly compensating individual upstream landowners through the provision of benefits such as beehives, apicultural training, and barbed wire. Transfers are made each year, conditional upon approval by a local monitoring and enforcement committee that verifies that the native vegetation has indeed been protected.

2. Local economy, land use and land tenure

The Los Negros valley covers approximately 26,900 ha, with about 35 kilometers separating the major population centers of upstream Santa Rosa (481 inhabitants) and downstream Los Negros (2970 inhabitants). The cloud forest that appears to be the most important native vegetation type for both water provision and biodiversity protection covers approximately 4000 ha (Fig. 1). Downstream irrigation canals provide water to about 1000 ha of intensively used agricultural lands around Los Negros.

Bordering the upper reaches of the Los Negros watershed is the 637,000 ha Amboró National Park, which supports an extraordinary variety of flora and fauna: at least 127 species of mammals, 105 species of reptiles, 73 amphibian species and more than 800 bird species (http://www.amboro-bo.org/ecologia.htm). However, the national park and its buffer zone are increasingly threatened by illegal land encroachments. Encouraged by farmers' unions and local political leaders, migrants from the Bolivian highlands (*altiplano*) frequently enter the buffer zone and the park itself to extract timber and to clear forest for agriculture.

The seasonally dropping water level of the Los Negros River has long been a point of contention among watershed communities. In the early 1990s, residents of Los Negros blocked the road to Santa Rosa, demanding that no more colonists enter and cut the forest at the headwaters. On a separate occasion, Los Negros sent a commission of government officials to Santa Rosa to arrange a system of 'irrigation turns' which would regulate how much and when irrigators could divert water from the river to their fields. In Los Negros, irrigators have organized themselves to construct and maintain eight canals, some of which have been operating since the 1960s. All have rules, regulations and enforcement systems, and each charges membership fees and dues. There is thus already a well-regulated, complex system of water management in the lower part of the watershed, and an adequate social organization to support it.

The Mesothermic valleys bioregion registers rural incomes similar to the Bolivian national average (US$1010 in 2005). In 2004, the average annual income in Santa Rosa was approximately 8000 Bs per year, or US$1000[2]; Los Negros is more prosperous than Santa Rosa, with an average annual income of 11,400 Bs (US$1426) (Vargas, 2004). In downstream Los Negros irrigated agriculture covers the valley floor. Major crops include tomatoes, onions, potatoes and carrots. Production is intensive with two or three harvests a year, with produce sold in the major markets of Santa Cruz and Cochabamba, which are reached by paved road from Los Negros. In the middle watershed agriculture is also irrigated, but with lower infrastructure investment. In the upper watershed rainfall is much higher (although no exact data have been collected), so rain-fed production of maize and beans predominates. Extensive cattle grazing is the preferred land use where agriculture is not possible. Natural vegetation—albeit disturbed by cattle—covers much of the valley sides, with dry shrub land downstream and cloud-forest upstream, and puna grasslands in the highest-altitude areas.

Land-tenure arrangements in the valley are variable and complex. In the upstream communities of Santa Rosa, Palmasola, Sivingal and Agua Clarita, few landowners have government-approved title, but rather rely on signed purchase contracts, some of which are generations old, as proof of possession. Such proofs are locally accepted for plots that are actively managed. However, landless immigrants view forested areas not delimited by barbed wire as unused and available for colonization. Many new immigrants clear land illegally or 'informally', i.e. on land owned by other farmers or within the national park, and establish possession without any supporting documentation. Some of these land-clearers are wary of increased attention on conservation in the valley, fearing it is the first step to increased general regulation of land-use change (Robertson and Wunder, 2005).

Santa Rosa borders the Amboró National Park, but the exact limit of this border is disputed. A community order to protect the headwaters of the watershed precludes landowners whose plots border the park from deforesting higher than half way up the ridge as measured from the town. Compliance with this self-imposed limit on deforestation is reasonably high. The PES scheme is not currently compensating landowners for areas conserved by the community order.

New colonists and existing residents both deforest at about 1–1.5 ha per family per year, but there are different foci for the deforestation caused by the two groups. Current landowners tend to deforest young and old fallow areas as close as possible to existing communities, and hence away from the cloud forests that border Amboró National Park. In contrast, new colonists clear the mature old growth forest that is farthest from the communities and closer to the park, where land claims are weaker. In neighboring Rio Blanco 80 new colonist families

[2] Exchange rate of US$1 =7.99 Bolivianos (Bs.) as of November 23rd 2006.

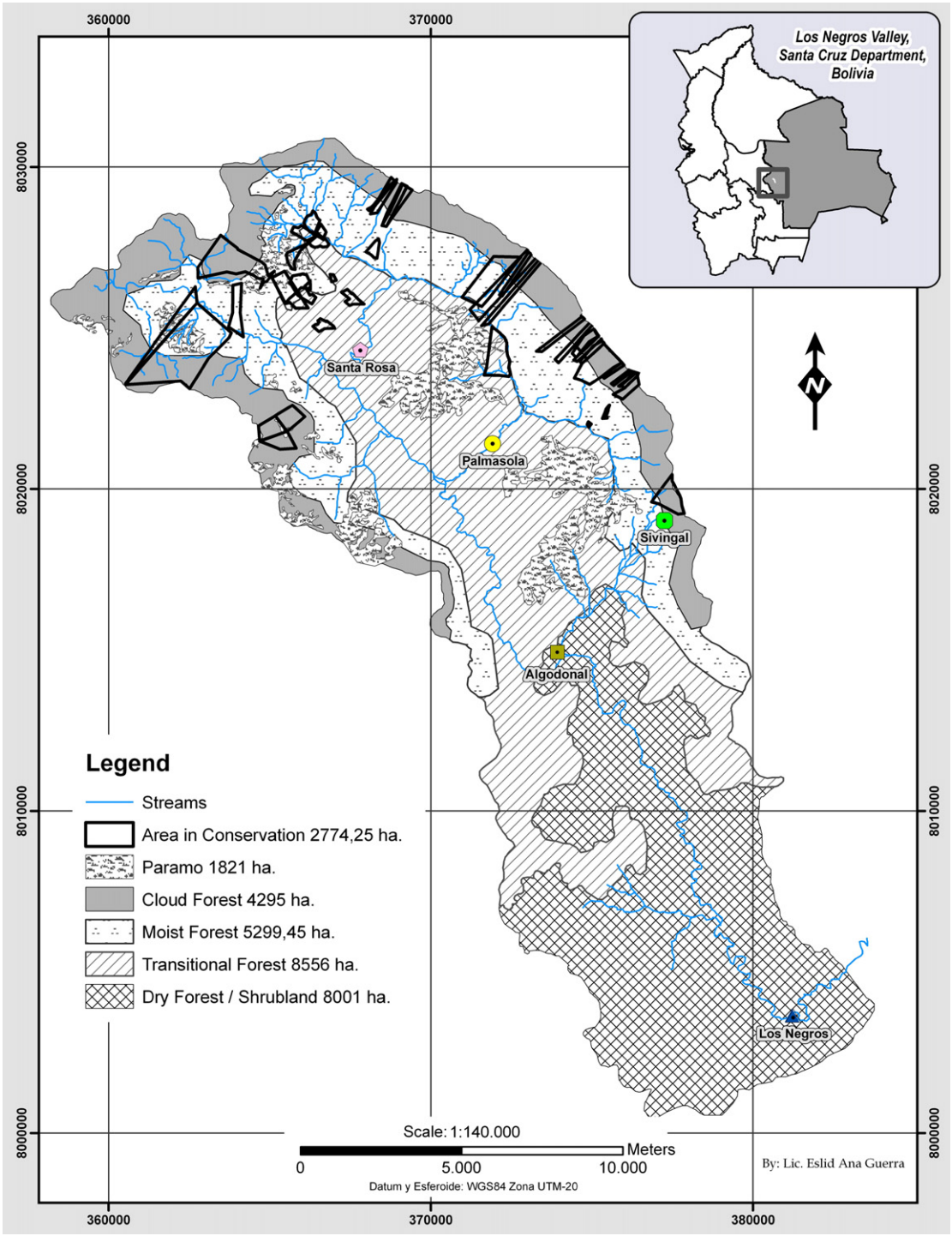

Fig. 1 – Vegetation types and PES conservation areas in the Los Negros valley.

cleared ~100 ha of old growth forest in 2005 (Galvis, pers. comm, 2005). Deforestation by new colonists is thus the greatest threat to the biodiverse cloud forests that border the park.

3. PES negotiations

In mid-2003 a local NGO, Fundación Natura Bolivia, began developing the capacity in the Los Negros watershed for a watershed PES system—the first of its kind in Bolivia. Natura decided to use Los Negros as a pilot PES site because of a number of favorable preconditions. First, only 1328 people lived in the upper part of the watershed, centered on the community of Santa Rosa, which facilitated discussions and negotiations. Second, in Los Negros town, irrigators constituted a potential long-term "service demander" group who perceived an increasing water-scarcity problem. Third, a clear local perception of forest–water links existed: with clouds

almost permanently present above the upstream forests, downstream farmers had a strong belief—albeit unsubstantiated scientifically—that forest protection and the maintenance of water supplies were linked (Rojas-Peña, pers. comm., 2004). Finally, the short linear distance from Santa Rosa to Los Negros town made stakeholder coordination more tractable.

Interest in PES from individuals in both upstream and downstream communities was immediate, though Natura also quickly realized that the key constraint to developing a system was the low level of confidence on behalf of both parties in the respective counterpart's PES contract compliance. In order to build mutual confidence that a PES system could work, Natura piloted most of the first three years of payments through biodiversity funds mobilized from an external donor. The US Fish and Wildlife Service agreed to fund PES start-up costs by supporting the long-term protection of the Los Negros cloud forests, provider of habitat for at least 11 species of Neotropical migratory birds.

It is not yet known if there is enough service value and a long-term "willingness to pay" (WTP) by downstream water users to compensate for upstream opportunity costs of land. No formal economic analysis or PES feasibility study was implemented, but Vargas (2004) carried out semi-structured interviews with 168 downstream and 32 upstream farmers to scrutinize land uses, crop types, yields and prices, and how production costs vary with water availability. For instance, an irrigated hectare of cropland costs 11 times as much as a non-irrigated one. Downstream farmers could thus tangibly protect both recurrent incomes and land values by any action that was successful at protecting stream flows. 70% of farmers in Los Negros stated a non-zero WTP for forest protection, summing up to US$12,487–19,728 (0.7–1.1% of household income) per year (Vargas, 2004).

4. Implementation and payment mode

The intermediary NGO provided the first motivation and impetus for the PES scheme, albeit initially based on a locally observed problem of increasing water scarcity. The US Fish and Wildlife Service provided biodiversity payments to prime the development of a local PES system until local counterpart funding could be found. The current buyer of the watershed service is the Municipality of Pampagrande, which has made two payments, the first of US$2000 in 2004, the second of US$2500 in 2007, to purchase bee boxes on behalf of the downstream irrigators. A small group of irrigators have individually also contributed a small amount, annually providing per diem and food (~US$5 per person) for the independent monitors of the conservation areas. With this exception, water users or their association are not yet paying for watershed protection.

All upper watershed landowners have been invited to voluntarily enter the PES program. Basically, service sellers choose to participate in the contingent conservation scheme at the established PES rates. They also decide what plot to enroll, and the time period of their contract. Building trust and confidence in the scheme among service providers has been a slow but positive process. Five farmers initially participated in the program in 2003, protecting 592 ha. They were joined in 2004 by seven more who protected an additional 252 ha, and by 2005 a total of 21 landowners were protecting 1111 ha. As of August 2007, 46 landowners were protecting 2774 ha of native vegetation, of which approx. 1335 ha were cloud forest. Of the 102 parcels in conservation, 63 were larger than 10 ha (Table 1). Contracts ranged in duration from 1–10 years. Payments are made once annually, and honored contracts can be re-enrolled into the program in subsequent years. Total payments are currently approximately US$5000 per year. This amount compares with the approximate amount of US$40,000 spent by Natura to design and develop the initiative (including vehicle purchase and running costs, staff salaries and equipment and office costs), and the ~US$3000 in annual running transaction costs.

Measuring and demarcating forest conservation plots is undertaken with a hand-held GPS receiver, the data later being plotted onto a 2001 satellite image-based land-use map. The various forest types in the parcel are then mapped and their areas calculated. Farmers receive a copy of "their" map along with their contract. Field demarcation is by natural boundaries or trails, signs and wire fencing.

One noteworthy implementation feature of the scheme is the non-cash mode of payment. During the negotiation phase

Table 1 – Conservation parcel distribution in the Los Negros PES system

2007	Primary forest without any previous or current intervention		Grassland without intervention	Old growth forest currently subject to cattle grazing		Secondary forest
	Cloud forest	Moist forest		Temporary	Permanent	
	US$3/ha	US$2.25/ha	US$3/ha	US$2.25/ha	US$1.5/ha	US$1.5/ha
0–1 ha	–	2	2	1	–	5
1–10 ha	8	6	4	4	–	7
10–20 ha	11	5	3	5	1	–
20–50 ha	10	–	–	7	1	1
>50 ha	11	3	–	5	–	–
Total hectares enrolled	1334.98	528.17	70.27	749.26	46.05	45.52

Definitions: For a secondary forest to receive compensation it must not have been cut for more than ~20 years. A 'temporary intervention' in otherwise old growth forest refers to areas that are currently open to cattle grazing for less than 6 months a year, while 'permanent intervention' refers to areas open to cattle grazing for more than 6 months per year.
Note: The cash equivalent of $3/ha/year correlates to an in-kind payment of one bee box or one roll of barbed wire protected for a year.

(November 2003–January 2004), the environment committees of Santa Rosa and Los Negros met and after some iterations agreed on the annual payment of one artificial beehive for every 10 ha of forest protected for a year—a cash equivalent of ~US$3/ha/year, plus the value of accompanying apicultural training. The alternatives discussed were road improvements, and marketplace or bridge construction in Santa Rosa. The PES recipients in Santa Rosa specifically rejected the option of payments in cash. As one 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" (Robertson and Wunder, 2005).

This statement indicates not only reluctance to receive cash, but also recipients' expectations of integrated (and perhaps paternalistic) interventions: the mediating NGO is assumed to deliver a ready-made complete 'package' of benefits. This may well be a rational preference, since local capacities for savings, investment and entrepreneurship are limited. Other PES recipients said honey was a useful subsistence product, and receiving beehives caused less fear over land expropriation than cash transfers, whether such fears were grounded or not (Robertson and Wunder, 2005). On the other hand, during implementation the payment in beehives has also been questioned, and partly modified. Table 2 outlines some of the locally perceived pros and cons of cash versus in-kind payments.

While theoretically a problem, the 'indivisibility' of a beehive has not actually been a constraint: farmers with smaller conservation parcels simply contract to conserve for longer periods to maintain the equivalent payment. For example, 5 ha conserved for 2 years is equal to 10 ha for a year, and would similarly receive one beehive. For Natura and the service buyers, forest as preferred bee habitat for apiculture provides a reinforced local conservation incentive. In addition, some labor employed in beekeeping is diverted from slash-and-burn agriculture. The beehive 'demonstration effect' also seems to bring more local recognition than the tiny corresponding cash payments would do. This observation is supported by psychological research showing 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 traditional local systems of "social markets" (Heyman and Ariely, 2004).

However, some farmers wanting cash stressed the beehives' inflexibility as an economic asset, as well as the labor and skill requirements needed for it to yield returns, suggesting that less-dedicated and less-skilled beekeepers are receiving low or zero gains. Some recipients anticipated they would sell the next hives to those specializing in bees, thus creating an 'intra-village secondary market' exchanging bees for cash. Compensation packages have also been diversified, as some farmers have requested barbed wire and fruit tree seedlings instead of beehives, while still maintaining the same dollar-equivalent value payment. In the medium term, this diversification may reduce transaction costs, since it requires fewer resources to deliver a roll of wire than to train a farmer in beehive management. However, other reforms in payment modality increase costs: the beehive "project package" is on request being extended to include honey marketing, trying to make apiculture more rewarding. Of the 15 new entrants to the scheme in 2006, 14 preferred barbed wire for compensation, highlighting the perceived value of wire in strengthening land-tenure claims.

Table 2 – Locally perceived advantages and disadvantages of two PES payment modes in Santa Rosa: cash and in-kind transfers compared

Beehive (in-kind) pros/cash cons	Cash pros/beehive (in-kind) cons
– Some recipients reject money—it would be spent rapidly and leave no long-run benefits	– Some recipients little skilled and interested in beekeeping, thus losing benefits
– Paying cash "smells" more like giving up 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 gives PES implementers more goodwill than a corresponding cash transfer	– Extra costs for recipients to benefit because beekeeping demands labor inputs

Table adapted from Robertson and Wunder (2005).

5. Monitoring, compliance and sanctions

Compliance monitoring has simply focused on the land uses stipulated in the contract. Every 12 months the *Project Control Team* revisits the parcels of all farmers enrolled in the program. This committee comprises one member of the upstream community's environmental committee, one member of the downstream community's environmental committee, a Natura field technician, and the landowner. Monitoring costs of four per diems (US$20 per day total) are split between all parties. Equipped with GPS and maps, the group visits the conservation parcel in the field. The committee assesses whether the parcel has been effectively conserved, notes any changes, damages or other points of interest, and submits a written report. This report is submitted to the *Enforcement Directorate*, comprised of the President of Natura, and the presidents of both the upstream and downstream communities' environment committees. This Directorate makes a final recommendation on how to respond to any infractions.

There has so far been only one infraction of the conservation agreements, which occurred in 2005, when one landowner constructed a road through a part of his conservation parcel. Natura could not request that the landowner return his beehive, corresponding to the previous year's payment, due to the political consequences of enforcing such an expropriation. In practice, this means that landowners can regard the first, up-front payment as a "welcome gift" to enter the PES scheme (Robertson and Wunder, 2005). The Directorate decided on a rather mild penalty: exclusion from the program for only 1 year. It has since been decided that sanctions for infractions will be clearly stipulated in future agreements, and will comprise an exclusion of the landowner for 5 years if

conservation parcels are cleared while under contract. Thus, while the PES scheme has been designed to be truly *quid pro quo* vis-à-vis environmentally desirable land-use practices, enforcement of sanctions has been introduced only gradually.

6. Obstacles to implementation

Three major implementation constraints have been identified:

1) Lack of a credible downstream institution that could ensure service buyers will contribute equitably to the scheme;
2) A lack of trust by downstream farmers that payments to upstream farmers would actually lead to more conservation;
3) A fear among upstream farmers that the initiative is designed to appropriate their land.

PES implementers are currently focusing on alleviating the first problem—development of an acceptable and fair mechanism for attracting downstream contributions. The second issue is being resolved through demonstration: the first 3 years of pilot payments have shown that given appropriate incentives, upstream farmers will maintain forest in its natural state, and thus provide the promised environmental services. The third problem is being addressed by having a continued presence in the community, individually explaining the scheme to farmers, and by having their peers convince them to join the system.

Because sustained support for the PES scheme depends on understanding of the environmental linkages, in 2004 Natura began an environmental education project targeting teachers and school children in six watershed communities (Santa Rosa, Sivingal, Los Negros, Palmasola, Valle Hermoso and Pampagrande). Natura also held an introductory workshop with 17 downstream agriculturalists to discuss pressing problems of water management and efficient disposal of agrochemicals, and how to promote a basin-wide irrigator association to institutionalize problem solving.

7. Baseline establishment and additionality

There are two important and distinct aspects of additionality and baselines. We deal with each of these aspects in turn:

1) The relationship between land use and the environmental services of interest (hydrology and avian biodiversity); and
2) Additionality in terms of whether there has been a change in land use compared to the baseline.

Baseline water flow and bird species diversity were not established before the initiation of the scheme. Rather, baseline focus has been on vegetation cover and land uses assumed to significantly enhance service provision. A baseline map of land-use types in the Los Negros valley was developed from a single 2001 Landsat image (Fig. 1).

The lack of hydrological data means that many basic dynamic relationships remain unknown. For example, it is not clear how much of the observed reduction in downstream dry-season water stream flow is due to increased competition from upstream irrigator demand, rather than reduced supply. Nor is it known how much of reduced water supply would be due to factors other than local land-use changes, e.g. regional climate change. Even if PES implementers are correct to assume that loss of cloud-forest cover has and will continue to cause reductions in dry-season stream flow, other important unknowns include the *magnitude* of that forest–water relationship (i.e. how many liters/second of dry-season stream flow will be saved by the protection of one additional hectare?) and whether there are *threshold* effects (i.e. reduced marginal water gains, once a minimum of hectares have been protected/deforested).

A crude hydrological modeling exercise, using data available at the national level, found a likely link between deforestation in the Los Negros headwaters and decreased dry-season water flows in Los Negros. It predicted that an annual upper watershed deforestation rate of 0.8% would decrease dry-season stream flow in Los Negros by 75% over 10 years (Auza, 2005). However, only modeling using adequate local data can reach definite conclusions.

To resolve the problem of insufficient data, stream depth and flow are now regularly being measured at four points of the main Los Negros River, and in eight of its tributaries. Four of these tributaries are heavily forested, while the other four have been significantly disturbed. Twice-weekly water depth measurements, periodic stream flow velocity calibrations, and daily rainfall measurements are helping to build a hydrological baseline and monitoring scheme. The objective of this small-scale study (costing <US$10,000) is to add basic knowledge as to if and where protection of upstream forests likely creates hydrological service, to the benefit of PES implementers and, perhaps, to further persuade downstream water users that it is worthwhile paying. Until enough data have been collected and analyzed, though, the watershed protection component of the PES scheme will depend on the extrapolation from findings in other sites, where a positive effect from cloud-forest and puna grassland vegetation cover on dry-season flows has been demonstrated (Calder, 1999; Bruijnzeel, 2004).

In terms of biodiversity protection services, an avifaunal survey (Blendinger, 2005) contributed to a baseline for bird species diversity. During 223 hours of data collection in February–March 2005, 6639 individual birds were recorded in the Los Negros valley, representing 235 species and 45 families, of which 11 species were Neotropical migrants (4.6% of the avifauna censused).[3] Several of the census points were located in forest parcels that are now being protected through PES. The census report found highest bird diversity in cloud forests (Blendinger, 2005). This suggests that the current PES focus on the cloud forests in the northern third of the basin is appropriate from a biodiversity point of view.

The second important additionality aspect relates to whether there has been a change in land use compared to

[3] These Neotropical migrants comprised: *Actitis macularia*, *Elanoides forficatus*, *Buteo platypterus*, *Catharus ustulatus*, *Coccyzus americanus*, *Contopus cooperi*, *Empidonax alnorum*, *Tringa solitaria*, *Cathartes aura*, *Vireo olivaceus*, and *Falco sparverius* (Blendinger, 2005).

the baseline. Forest cover in the Los Negros valley is certainly declining over time. Over the last three years between 95 and 140 ha, or 2.3–3.5% of Santa Rosa's ~4000 ha of cloud forest, have been deforested per year (authors' estimates). Outside the parcels enrolled in the scheme, the greatest land-use change threats to provision of environmental services in the valley occur on steep slopes and remote areas (many of which are close to the park) where enforcement of existing land ownership claims is weakest.

Nevertheless, at this early stage of the initiative, the PES system itself has perhaps achieved little in terms of additionality vis-à-vis landowners' conservation behavior (Table 3). As noted by Robertson and Wunder (2005): "In terms of land-use change, the land currently put under conservation contracts is not the most threatened by agricultural clearing, if it is in danger at all". This is because—in contrast to forest parcels where land claims are weak—the steep, inaccessible forests that have clear ownership are at low risk of deforestation. Upstream farmers are thus likely adopting a risk-averse strategy and trying out the PES concept by enrolling patches of their forests they would likely not have cut anyway—for example, remote, steeply sloped areas with a poor agricultural potential.

Farm size in Santa Rosa varies between 2 and >500 ha, and within each farm between 0% and 80% is forested. Since the capacity of annual agricultural clearing is typically constrained to 1–1.5 ha per household, there is at any moment considerable non-threatened land available to enroll in conservation, and continue to do business as usual. The US$3/ha/year value of the beehive transfers is usually less than the conservation opportunity cost, so in purely economic terms PES rates likely remain a non-competitive alternative to forest conversion in all but the furthest and most inaccessible forests.

One potential remedy would be to move to a more proactive strategy of negotiating entire blocks of desired conservation areas. As long as landowners can freely offer any self-selected areas for involvement, as is currently the case, the rational farmer with a 100 ha sized forest would over the next five years annually clear the one hectare that he would have deforested anyhow, and offer the remaining 95 ha of "passive" reserve land for PES enrollment, at zero conservation additionality. Conversely, if conservation contracts were to be made for the entire farm holdings (or pre-determined target blocks), this 'on-farm leakage' is precluded. As shown for the Pimampiro case (Wunder and Albán, this issue), relatively small per-hectare payments could still be competitive in this case, as long as at any point in time only a minor share of a relatively large forest area is threatened by clearing: for the above landowner, receiving US $300/year for protecting the entire 100 ha of forest might still be attractive, compared to the incremental net gains from clearing one hectare every five years.

In terms of the declared objective to change local landowners' behavior by providing forest conservation incentives, the PES initiative may thus not be performing so far, perhaps except for a minor diversion of labor efforts dedicated to beekeeping—an unintended consequence. However, there seems to be a much more pronounced additionality effect: controlling colonization by landless people. In Santa Rosa, a clear perception exists that formalized contracts with maps and demarcations, in this case for PES, help institutionalize *de facto* land-tenure security, thus reinforcing intra-village acceptance of tenure claims (Robertson and Wunder, 2005), and raising the probability of successfully resisting invasions (c.f. Umbeck, 1977). Over the lifetime of the scheme, no successful migrant invasion has occurred on PES-enrolled land. Indicative for the strategy of PES *cum* tenure consolidation is also the increasing number of landowners that have requested to be paid by barbed wire as an in-kind PES, which they utilize to fence off their land. Over time, as migrant threats of land clearance increase, PES implementers expect that farmers may begin to enroll more of their land out of a fear of losing it. Such expansion will probably become easier to implement once local trust in the scheme has been further developed.

Table 3 – Likely environmental threat changes on PES-enrolled lands

Threats	Threat level before PES	Threat level after PES [a]	Land area affected (ha)	Conservation effect
Land clearing by local landholders	Low	Zero	2774 [b]	Negligible
Land clearing by landless colonists	Medium	Zero	2774 [b]	Positive
Forest degradation from cattle grazing	Medium	Zero	1933	Positive
Timber extraction	Low	Zero	2774 [b]	Negligible
Hunting	Low	Minimal	2774 [b]	Negligible

Source: Table adapted from Robertson and Wunder (2005).
[a] Because of a lack of monitoring, these threat levels are estimates, based on information gathered through interviews by the authors on potential additionality and leakage.
[b] Total land area enrolled under PES in 2007.

8. Permanence and leakage

Permanence is not an objective that scheme implementers have strived for: contracts are for a maximum of 10 years, and deliberately not linked to long-term conservation agreements. This has been a political decision—in order to minimize pre-existing fears of land appropriation of permanent clearing prohibitions being introduced through the back door. An initial attempt to push semi-permanent commitments might have deepened local mistrust about the true objectives and nature of the PES initiative (Robertson and Wunder, 2005). However, with incremental trust building landowners have voluntarily demanded on average longer contracts, as they realize the scheme can work in their favor, and with longer contracts leading to larger up-front payments.

The amount of 'leakage' from the project has not been measured. As mentioned above, since contracts are not based on total farm size, there is likely some 'on-farm leakage'. In addition, migrants who are precluded from clearing land in Santa Rosa might turn elsewhere for invasion. There are currently no data to test this hypothesis, but at least it seems unlikely that this invasion would occur in the same watershed, and thus affect the same service.

9. Spatial differentiation

In 2005, Natura introduced a new, and generally well-accepted, concept to landowners: that some vegetation types were worth protecting more than others. Payments were designed to depend on the explicit criteria of vegetation type and conservation quality. Intact cloud forest and grasslands continue to receive US $3/ha/year, reflecting their supposed primary importance in both water provision and as bird habitat. Non-cloud primary forest, occurring at lower elevations, is presumed to be slightly less valuable for water provision and bird habitat, so receives US $2.25/ha/year. By the same logic, mature secondary (cloud or non-cloud) forest, or forest that is disturbed by permanent cattle grazing, receives US$1.5/ha/year, while the still less important young secondary forest and disturbed grassland currently receive no compensation. Table 1 (above) shows both the criteria definitions and the contract distributions.

10. Participation of disadvantaged groups and livelihood impacts

There has been no deliberate targeting of disadvantaged recipient groups in the PES scheme. Indeed, the poorest in Santa Rosa, the landless immigrants, are unable to participate, because they have no land from which to provide an environmental service. In general, they are also the ones most likely to lose out from successful PES implementation: as argued above, PES reduces effectively invasions on lands kept passively under forest. Finally, to the extent that PES will at some stage effectively curb pre-established landowners' agricultural expansion, landless groups would also lose out from lost jobs as wage laborers.

However, the scheme also has activity-enhancing effects that benefit the landless. Some PES participants have sold beehives to landless people specializing in apiculture (Robertson and Wunder, 2005). One landless worker is employed by the initiative to undertake hydrological measurements; while another has been hired by the farmers as a roving "bee expert" who helps with hive management. Other farmers are hiring landless community members to help with honey processing.

Among PES participants, there are many moderately poor farmers. How have their livelihoods been affected by the scheme? The transfer of a beehive as a physical asset has a cash value of US$30. Independent of the size of enrolled land, PES participants have in addition received apicultural training, which measured by its costs corresponds to a gain in human capital of about US$35 per participant. Natura introduced a unique benefit package that farmers would probably not have been able to assemble on their own. Yet, welfare effects are not determined by asset transfer values (unless these are sold directly), but by their returns over time. In practice, the returns to beekeeping have been extremely skill-dependent; not everyone in the village has been equally successful. Considering honey yields, labor requirements, the going wage rate and a 15 year expected lifetime of beehives, the net present values of beehive transfers range between −US$15.25/ha/year (negative value) and +US$12.66/ha/year (Robertson and Wunder, 2005). Thus, the most skillful and lucky beekeepers would make a return over 15 years that quadruples the value of the hive assets, whilst the less fortunate ones would make a considerable loss—meaning that their apicultural labor would be remunerated significantly below the going wage rate. This result can help explain why some PES recipients prefer alternative modes of payments, while others continue to specialize in apiculture.

11. Next steps

Three problems are critical to resolve if the Los Negros PES scheme is to be sustainable:

1) The area of different protected vegetation types needed to maintain a specific average dry-season water flow is unknown. Hydrological service buyers are therefore being asked to bear all the risks of the scheme, and to pay for a service that they cannot yet precisely define. This makes it less attractive for them to participate.
2) Not enough is known about farmers' differential opportunity cost of protecting land, nor are current incentives working satisfactorily. Farmers are accepting current payments of US$3/ha/year on 2774 ha of PES-enrolled land, but those may carry zero or close-to-zero opportunity costs to landowners. To increase additionality, contracts need to be redesigned to focus on the entire farm or 'tied land blocks', not just a share voluntarily enrolled at the discretion of the landowner. Other payment mechanisms, such as replacing flat payments with inverse auction (see Ferraro, this issue) may also increase environmental efficiency.
3) In spite of a pre-stated willingness to pay, downstream water users may in the short run *de facto* contribute little to PES. Gaining local financial support for payments has proven elusive, though by August 2007 the idea of contributing to the initiative had finally begun to gain traction within the local water cooperative. Indeed, in December 2007, the cooperative's members voted for a 9% increase in water rates with all funds going to an earmarked bank account for upstream forest protection. However it seems likely that some biodiversity payments would still be required for the scheme to continue at the current per-hectare rates. The initiative must therefore also adopt more specific spatial targeting of interventions, in order to demonstrate more clearly how much of each service it is likely providing.

The Los Negros initiative was designed to be implemented adaptively. Lessons are constantly being learned, difficulties are discussed with participants, and interventions are modified. In that sense, many themes and activities detailed in this paper remain hypotheses being tested. With gradually accumulated experiences, Natura is replicating the Los Negros initiative in the nearby Comarapa and Quirusillas watersheds, identified by Muller (2005a,b) as among the top five in Bolivia most apt for the development of PES systems. Both of these upper watersheds are covered by cloud forest that is threatened by land-use changes, especially expanding cattle ranching. Downstream users there are highly dependent on dry-season water flows to support large areas of irrigated agriculture, and are relatively well off. Comarapa already has a donor-funded dam, and Quirusillas is about to begin its dam construction. If deforestation and grassland conversion

continue in the upper watersheds, both dams run the risk of siltation, reducing their useful lifespans (Asquith and Vargas, 2007).

12. Discussion

Local water users in Bolivia are often unable to sustainably manage their water resources, because they lack accurate information, fair institutional mechanisms, and appropriate incentives. The model being piloted in Los Negros tries to address these three obstacles by introducing an incentive-based, transparent system of watershed management. It has achieved some milestones to date. After significant initial resistance, by August, 2007, 46 farmers had enrolled 2774 ha of land under PES. Most of this land is protected for its biodiversity values, and most likely also contributes to improved dry-season water flows benefiting downstream water users. The scheme also clearly improves income on most participating upstream farms, which has been reflected in growing enrollment.

Three other design issues of the Los Negros scheme are noteworthy with respect to other PES schemes. First, local actors have in their negotiations about the most adequate compensation package preferred in-kind beehive delivery to cash, a choice that may be rational given local constraints to absorb liquid cash in a manner that enhances welfare over the long term. However, the initial "contingent project approach" (beehive transfer plus technical assistance) is already being supplemented by other in-kind payments without technical assistance, underlining the need to customize payment modes in a way that flexibly meets local requirements while minimizing transaction costs for the buyers and intermediaries.

Second, Natura deliberately chose to develop a dual-service PES scheme. Given that forest conservation in Santa Rosa provides several services—carbon, biodiversity, and watershed protection, pollination etc.—each one of which can be used (and potentially paid for) without jeopardizing the provision of the other services, different sources of funding could in principle be tapped to make conservation profitable. The dual-service strategy thus allowed the scheme to get started, and to overcome financial constraints. The international biodiversity buyer was able to provide relatively large up-front biodiversity payments that covered many start-up and transaction costs, but such funding likely has a finite time horizon. Complementarily, local water service users are less willing and able to fund set-up or transaction costs, but may be more likely to provide a sustainable long-term payment stream.

In terms of service provision, there appears to be some overlap between the areas perceived to be important for water (dry-season flow) and the areas of biodiversity interest (avian diversity)—in particular, with respect to high-altitude cloud forest, old growth moist forest and wet puna grasslands that comprise 70% of the vegetation currently protected. However, using biodiversity payments to pump-prime the scheme may also have created a perverse incentive for downstream users—why should they pay when someone is already doing it for them? The potential for free-riding remains one of the dual-service scheme's weaknesses. Perhaps the Los Negros initiative has so far been better at revealing effective ways to transact with upland service providers, rather than answering the key question of where the money should/can best come from to sustain these transactions.

Finally, many PES observers recommend an intensive data collection phase before PES implementation (e.g. Landell Mills and Porras, 2002; Bracer et al., 2007). Natura had a different approach, reasoning that the best way to start was to earn local goodwill by piloting biodiversity payments of ~US$1800, before any baseline data were available. The guiding logic was that PES structure could most effectively be learned and data best collected through learning by doing and adaptive management. The downside of this approach is that significant changes have to be made as the initiative develops. However, the difficulties of implementing these adaptive reforms have been less than could have been feared: even reducing the per-hectare remuneration rates in a switch to a differentiated system has met basically no resistance among landholders. Other, larger-scale schemes such as the national Mexican PES (Muñoz et al., this issue) have also been initiated before all the 'necessary' in-depth research was undertaken. The example of Los Negros with a "learning-by-doing" PES strategy may serve to encourage others to jump into the water more quickly: learn main lessons when money is already changing hands, rather than trying to architect all the details in advance.

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