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PAYMENTS FOR ENVIRONMENTAL SERVICES IN WATERSHEDS: INSIGHTS FROM A COMPARATIVE STUDY OF TWO CASES IN CENTRAL AMERICA

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Abstract

We have compared two cases of payments for environmental (hydrological) services (PES) in Central America, in terms of socioeconomic background, opportunity costs of forest conservation and stakeholders' perceptions on the conditions of water resources and other water-related issues. We found that, in general, the forgone benefits from land uses alternative to forest cover are larger that the amount of the payment, which contradicts the economic foundation of PES schemes. A number of possible explanations are explored. The results suggest that trade-offs between different environmental and social goals are likely to emerge in PES schemes, which poses some doubts on their ability to be multipurpose instruments for environmental improvement and rural development. We also found that PES schemes may work as a conflict-resolution instrument, facilitating the interaction between downstream and upstream stakeholders.

Key words: environmental services, watershed management, Honduras, Costa Rica

1. Introduction

Even though the theoretical foundation of the payments for environmental services (PES) was set several decades ago (Coase, 1960), the practical implementation of these market-based instruments for managing natural resources has started recently. So far, a number of payment schemes at the watershed level have been already implemented, mainly in Latin America and Asia, which allows drawing preliminary lessons (Landell-Mills and Porras, 2002; Mayrand and Paquin, 2004; Warner et al., 2004; Rosa et al., 2004). These schemes stem from the fact that natural or human-managed ecosystems provide positive environmental externalities that normally are not taken into account in individual economic decisions (Pagiola et al., 2002a). The term "environmental services" refers to these positive externalities, which usually are taken for granted. In watersheds, a number of different types of markets for environmental services have been described, from voluntary contractual arrangements to marketable permit systems (Tognetti et al., 2005). The two cases analyzed in the present paper constitute examples of voluntary direct payments from downstream water users to upstream providers of environmental (hydrological) services, through the action of an intermediary agency.

The economic rationale of PES schemes dealing with the promotion of particular land use changes in watersheds is straightforward: by means of establishing market transactions between downstream and upstream economic agents, the downstream effects are taken into account when upstream landholders make decisions about their own land use. This should lead to a larger social economic efficiency. Besides, direct payments are expected to be more cost-effective in meeting the environmental and local development goals, as compared to indirect means of financing a better stewardship of natural resources (Ferraro and Kiss, 2002). PES schemes are derived from the Coase's theorem. Namely, in a free market with no transaction cost, the gains in efficiency due to the internalization of environmental externalities are independent from the direction of the payment, and the initial endowment of property rights. Hence, the adoption of the polluter-pay principle is not a condition for achieving a Pareto better situation when applying this kind of instruments. In fact, most payments schemes addressing hydrological services in watersheds do not hold the polluter-pay principle, since upstream landholders are in general compensated for avoiding/reducing negative environmental externalities. However, the payments schemes for environmental services should fulfill the following two conditions in order to be efficient: i) the compensation of upstream landholders should be at least equal to the opportunity cost of land use changes (the forgone benefits for adopting or keeping the land uses or practices promoted by the scheme); and ii) the amount of the payment should be lower than the economic value of the environmental externality (for example, the abatement cost of improving water quality up to the desired level). In the case of PES schemes, compensating upstream landholders for maintaining forest cover, the amount offered to providers should be equal to the potential profits derived from land uses alternative to forest cover, in order to be efficient.

The payments for environmental services have been proposed as promising tools, alternative to command-and-control instruments, for forest protection (Nathan and Kelkar, 2001), biodiversity conservation (Pagiola et al., 2004) and watershed management (FAO, 2004). They fit well into the current trend towards decentralized and self-organized systems for water and forest management. Typically, command-and-control institutions and policy may be effective in controlling pollution from well-defined point sources, such as factories or sewage treatment plants. However, they are less effective in regulating non-point sources of pollution, such as those occurring when numerous upstream landholders dedicate their land to intensive agricultural or cattle-ranching activities. In those cases, downstream water pollution (or scarcity) is the result of the combination of individual actions carried out by geographically spread and heterogeneous upstream users (Lubell et al., 2002).

In watersheds, direct use rights on forests are often restricted to upstream landholders. Nonetheless, forests provide a variety of environmental services to diverse stakeholders, at different geographical scales, and there is rivalry in the consumption of forest goods and services — in other words, the consumption by one individual of forest goods might reduce the extent forest services are available for others—. For example, upstream deforestation related to extraction of firewood may induce a deterioration of water quality downstream. Thus, as in the case of common property resources (Gibson et al., 2000; Ostrom et al., 2002), the resolution of conflicts between different beneficiaries of environmental goods and services from forests typically involves collectively beneficial but individually costly actions. Economic incentives (for compensating those costly actions adopted by individuals) are supposed to be particularly effective in such cases (Seabright, 1993). Besides, the institutional arrangement of PES schemes may contribute to lower transaction and monitoring costs, which are normally assumed to be critical features for solving collective action problems (Taylor and Singleton, 1993).

In tropical watersheds (in developing countries), the most economically vulnerable groups tend to be located in upstream areas, where land is usually less productive and more prone to suffer erosion. Nevertheless, these rural communities are often providers of environmental services benefiting other groups with a better socioeconomic situation (generally located in downstream urban areas).

Hence PES are also expected to contribute to poverty alleviation and to reduce the overall cost of improving the condition of natural resources, by means of creating rural/urban economic linkages and economic incentives for good land stewardship (Pagiola et al., 2002b; Pagiola et al., 2005). These instruments might also play a critical role in raising awareness about the economic benefits natural ecosystems provide. Hence, PES may work as (win-win) multipurpose instruments, contributing to improve the conditions of different types of natural resources at the same time (e.g. forests and water), raising awareness about the economic role of ecosystems and contributing to the redistribution of wealth between different regions or social groups (Landell-Mills, 2002).

The aim of this article is to compare two cases of payments for environmental (hydrological) services in watersheds, in order to draw lessons about the design, functioning, and local impacts of PES schemes. The cases are compared in terms of upstream opportunity cost, impacts on income, and different perception of stakeholders. The following section describes briefly the methodology used. Section 3 summarizes main results. Section 4 discusses the results and develops some insights for PES design.

2. Methodology

The fieldwork was carried out in Jesus de Otoro (Honduras) and Heredia (Costa Rica) between July and December 2004. This study was part of a larger research program aiming to compare several schemes of PES in watersheds in Latin America. The two case studies were compared in terms of perception of different stakeholders, institutional context, opportunity costs of upstream land use, and local economic implications of the payment scheme. Stakeholders were classified into four main categories: users, providers, potential providers and intermediaries. Users are the beneficiaries of the environmental services that "providers" render. In our case studies, the users are downstream water consumers in urban areas, who pay an additional fee in their water bill, which is allocated to the PES scheme. Providers are upstream agents actively participating in the PES scheme by means of a contractual relation (with the intermediary) regulating land use. Potential providers are those upstream landholders that are not currently part of the scheme, but may become part of it in the future. The intermediaries are the entities mediating transfer of resources between users and providers. In our cases, the intermediaries are a grassroots non-profit organization (Jesus de Otoro) and a local public enterprise (Heredia).

We used a combination of quantitative and qualitative research techniques. Structured questionnaires were administered to users, semi-structured questionnaires to providers and potential providers, and in-depth interviews to key informants. We also collected a large variety of relevant secondary information on legal, institutional and socioeconomic context. The questionnaires differed depending on the target group, however all included three main sections: background information, economic aspects and perceptions on the PES scheme, the condition of water resources and other water-related issues. Altogether, we conducted 18 interviews and 117 questionnaires in Honduras; and 7 interviews and 111 questionnaires in Costa Rica.

The opportunity costs of maintaining forest cover was estimated by means of calculating three proxy variables: a) the net profits from on-farm activities that would be forgone; b) providers' willingness to accept as a "fair price" for PES; and c) the rent that according to the providers would be obtained if the land was rented out willingness to rent the land. In theory, these three variables should converge, particularly in those cases when farmers depend on their land for ensuring their livelihoods. However, in practice (see below) they might differ considerably. In the present article, net on-farm profits per unit area are defined as:

$$P = (R - PL - IL - I)/A$$

Where R is the value of the total annual sale of agriculture and cattle ranching products. PL is the aggregated annual cost of paid labor in agriculture and cattle ranching. IL is the aggregated annual cost of imputed (own) labor. We are therefore assuming that there are off-farm employment opportunities. I is the annual cost of inputs (agrochemicals, water, energy, etc.). A is the area dedicated to agriculture and cattle ranching. The second method for estimating opportunity costs consisted in asking providers to reveal what they consider a fair payment for environmental (hydrological) services from their lands. The third method consisted in asking providers about the price they would ask if they were to rent the land. The "degree of compensation" is finally calculated deducting each of the values obtained by means of the above-mentioned methods from the amount of the PES. A negative value for the "degree of compensation" means that the land uses alternative to forest cover are more profitable than the amounts offered by the PES scheme.

In both cases, we have assumed that agriculture and cattle ranching were the most likely alternative land uses to forest cover, even though in Heredia urbanization is also a very probable option. The PES scheme in Jesus de Otoro compensates upstream landholders not only for conserving forests, but also for adopting better environmental practices. However, we could not estimate the opportunity cost of adopting such practices, because our methodology did not allow a comparison of the economic performance of landholders before and after the adoption of better environmental practices.

3. Results

3.1 Description of the case studies

Jesus de Otoro, Honduras

Jesus de Otoro is located in the Department of Itibucá, in the Center-West of Honduras. It has around 5,200 inhabitants, 70 % of which benefit from water services (the other 30% take water from wells or directly from the river). The water consumed in this town comes from the watershed of the Cumes River. The area of the watershed is about 3,180 ha. Around 53 % of the watershed is covered by forest. Local forests are dominated by various species of pines and oaks. Part of the watershed is within the natural reserve Montecillos (protected area). The highest elevation of this watershed is approximately 2,200 m.a.s.l. Coffee plantations are very common in the upstream area. The most common land tenure is private property, and the main economic activity in the region is agriculture. The PES scheme in this locality was launched in 2002. At the time the fieldwork was conducted, the scheme offered payments to only 4 providers and covered around 22 ha. Later, the coverage was expanded to 18 providers and 74 ha. We could interview 3 out the 4 providers, since one of them was abroad. The scheme is meant to promote both the adoption of better environmental practices and the conservation of forests, and it is expected to cover around 200 ha in the future. The amount of the payment depends on the number of better practices adopted and on the type of the protection of forests. The amounts of the payments are summarized in Table 1. The better environmental practices promoted are:

- No burning before, during or after planting
- Construction of vegetal fences, irrigation ditches and terraces.
- Establishment of agroforestry systems
- Production of organic fertilizers
- Recycling of coffee pulp and management of wastes from coffee processing
- Implementation of organic agriculture
- Forest protection and reforestation

Table 1. Jesus de Otoro. Amounts paid to providers for different categories of land use. (US $/ha/year)

	Primary forest	*Secondary forest*	*Young forest*
Forest	5.52	4.14	2.76
Type of Crop	*2 better practices adopted*	*3 practices*	*4 practices or more*
Short cycle crop	5.52	8.29	11.05
Permanent crop	8.29	11.05	13.81
Agroforestry	11.05	13.81	16.57

The local Council for Administration of Water and Sewage Disposal (Junta Administradora de Agua Potable y Disposición de Excretas –JAPOE) administers the fund of the scheme. JAPOE is a non-profit organization, created, as a legal entity in 1995 from a local initiative with support from the Catholic Relief Service (CRS). Its role is to manage water provision and sanitation in Jesus de Otoro. The creation of the JAPOE was a response to serious difficulties in elation to water access and quality that Jesus de Otoro faced at the beginning of 1990s. The Municipality accepted to render the management of water and sanitation services to the JAPOE. The authorities of the JAPOE are elected in general assemblies in 10 different sectors of the town, thus it constitutes a decentralized and participatory institution for urban management of water and sanitation. The JAPOE charges water fees to 1,269 households. Water users also pay an additional fee in their water bill for the PES scheme, which in 2004 was 0.06 US$ (1 Lempira) per household per month. The Municipality is supposed to contribute with 1% of its annual income to the PES fund. However, at the time the fieldwork was conducted, this contribution has not made effective. Fees from water users and the contribution from the Municipality constitute the two sources of financial resources of the fund. The Municipality is also in charge of auditing the fund and has delegated an environmental technician for supporting monitoring and control activities of the PES scheme. The JAPOE signs a contract with each of the providers. In these contracts, the amount of the payment and the commitments for upstream land use changes are set.

Before the implementation of the PES scheme, conflicts between downstream dwellers and upstream coffee producers were common, and the relationship between the JAPOE and the association of coffee producers was most of the time conflictive. In 1996, arguing that coffee production and processing was the main source of water pollution, a group of downstream dwellers destroyed with machetes coffee seedbeds of upstream producers. This violent action aggravated considerably the downstream-upstream conflict. In 2001, the Program for Sustainable Agriculture in Hillsides of Central America (PASOLAC), financed by the Swiss international cooperation, proposed to the JAPOE to create a fund for establishing a payment scheme for environmental services in the watershed, and provided a seed fund of 4,000 US$. The creation of the scheme was supported by three technical studies: a) an assessment of water quality and quantity; b) a diagnosis of environmental services and c) an economic valuation. Regardless of the quality of these studies and the reliability of their results, the use of the technical assessments in the design of the fund was not clear-cut. For example, the actual fee for PES was only 3.6 % of the estimated willingness to pay among water users. The actual amount of the fee was decided politically at the JAPOE (through voting of representatives from the different water sectors in town). The overall cost of design and initial implementation of the scheme was about 30,000 US$.

Heredia, Costa Rica

Heredia is part of the large urban conglomeration of the Central Valley of Costa Rica. Water for this city comes from the watershed of the Virilla River, particularly from the sub-watershed of the rivers Segundo, Ciruelas y Tibás. The area of the watershed that provides water to Heredia is approximately 11,340 ha, and the highest elevation is around 2250 m.a.s.l. The PES scheme in this locality was designed and is currently managed by ESPH S.A, a public local enterprise for water provision and sanitation. In this case, the users are 48,667 households that legally hire the services of ESPH S.A. in Heredia and its surroundings. Superficial waters allow covering around 55% (annual average) of the local demand for water, the rest is extracted from water wells. Part of the National Park Braulio Carrillo is located in this watershed. About 34% of the Virilla watershed is covered by forest. In the region, there are three main types of forest: montane forest, cloud forest, and forests dominated by Alder (*Alnus acuminata).* The PES scheme in Heredia was created in 2002, by initiative of ESPH, in order to avoid deterioration of the upstream area of the watershed, where water sources are located. The scheme has prioritized 1,062 ha in the upstream area, from which 415 ha are currently part of the scheme. At the time the fieldwork was conducted, there were 10 providers. All of them were interviewed. The scheme has identified 29 landholders as potential providers. However, none of them were willing to be interviewed for this study. The most common land tenure in the upstream area is private property. Agriculture, cattle ranching and urbanization coexist in the upstream zone. This area has also become a high-status residence (or leisure) place for liberal professionals, who normally work in downstream urban areas. All the providers interviewed, except one, held a university degree. As in the case of Jesus de Otoro, in Hereria water users contribute to the PES scheme by means of an additional fee to their regular water bill. At the time of the fieldwork, users paid 0.008 US$/m^3 to the PES scheme, which was about 6% of the normal water fee for households. Providers have to hire a forest steward (*regente forestal*), who is in charge of monitoring the agreed land use and practices. Table 2 summarizes the amounts paid to providers for forest conservation and reforestation. The scheme promotes the following land uses and practices:

- Prevention and control of forest fires
- No hunting or illegal extraction of forest products
- No extraction of wood related products
- Forest conservation: no forest conversion to agriculture or cattle ranching
- Reforestation (optional)

Table 2. Heredia. Amounts paid to providers for different categories of land use. (US $/ha/year)

Land use	**Amount (US$/ha/year)**
Forest conservation	51
Reforestation, first year	124
Reforestation, second year	100
Reforestation, from third to fifth year	67

In 2003, the scheme also invested a considerable part of the fund to land adquisition in the upstream area. The technical studies supporting the initial design of the scheme proposed to charge an additional fee of 0.02 US$/m^3 to households, estimated the opportunity cost of upstream land (for milk production) in about 118 US$/ha/year and the economic value of the environmental services of forests in 2,190 US$/ha/year. Nevertheless, similarly to what happened in Jesus de Otoro, the relationship between the outputs of the technical studies supporting the initial design of the scheme and its final functioning and structure was not straightforward. For example, the amount of the fee charged to users was decided on political grounds, and it is considerable lower than the estimated willingness to pay of users. The cost of the initial implementation of the scheme was about 32,000 US$.

3.2 Quantitative analysis.

The socioeconomic characteristics of both places differ noticeably. Whereas providers and potential providers in Jesus de Otoro are relatively poor peasants who rely to a large extent on their land for their livelihoods and self-consumption of food, in Heredia, providers are wealthy professionals who work in urban areas and hold the land as a residence or leisure space (see Tables 3, 4 and 5). Miranda et al. (2003) also found that the main beneficiaries of PES schemes in the Virilla watershed are wealthy landholders. In general, the national program for PES in Costa Rica mainly favors well-educated, high-income and urban-dwellers (reliant on off-farm activities) and large landholders (Zbinden and Lee, 2005). The average income of users in Heredia is also considerably higher than in Jesus de Otoro (see Table 6). Providers in Jesus de Otoro are traditional peasants, close to a subsistence economy. In Central America, peasant systems combine the production of traditional crops for self-consumption (typically maize and beans), with cash crops, such as coffee, banana, or pineapple, and other sources of off-farm income (usually commerce).

Table 3. Jesus de Otoro. Providers

Provider	Gross income (on-farm and off-farm)	PES (in a year) to gross income	PES/area	Net profits on farm	"Fair PES"	Willingness to rent	Main benefit from forest
	US$/year	*%*	*US$/ha/year*	*US$/ha/year*	*US$/ha/year*	*US$/ha/year*	
1	7625	0.4	15.9	210.0	15.6	52.9	Firewood
2	5374	1.2	11.9	328.7	55.6	106.6	Soil protectio n
3	12059	0.6	9.5	654.4	19.4	63.1	Regulatio n local climate
Average	**8352.8**		**12.4**	**397.7**	**30.2**	**74.2**	

Table 4. Jesus de Otoro. Potential providers

Potential Provider	Gross income (on farm and off-farm)	Net profits on farm	Willingness to rent
	US$/year	US$/ha/year	US$/ha/year
1	1353.4	262.4	79.4
2	3157.2	602.5	23.8
3	2956.5	1078.8	79.4
4	2266.9	-77.7	12.7
5	1165.0	231.1	44.1
6	835.9	384.1	14.7
7	1252.2	-188.9	111.1
8	2822.2	192.0	27.6
9	3582.7	287.3	33.9
10	1353.4	262.4	79.4
Average	**1939.2**	**277.2**	**42.7**

Table 5. Heredia. Providers

Provider	Gross income (on-farm and off-farm)	PES (in a year) to gross income	PES/area	Net profits on-farm	"Fair PES"	Willingness to rent	Main benefit from forest
	US$/year	%	US$/ha/year	US$/ha/year	US$/ha/year	US$/ha/year	Scenery
1	60000	0.7	43.0	0	227.3	200	Scenery
2	90377	0.5	21.4	34.0	50.0	400	Regulation of the local climate
3	13800	1.6	55.7	0	600.0	1,500	Water
4	171573	1.2	55.6	96.1	100.0	650	Biodiversity
5	19091	9.5	51.9	0	113.6	455	Scenery
6	13398	6.6	52.1	215.2	80.2	NA	Leisure
7	33679	1.3	30.3	44.6	30.3	120	Water
8	4522	6.9	52.3	16.7	68.2	105	Scenery
9	132000	0.1	49.0	0	100.0	300	Scenery
10	52110	21.8	42.2	-65.9	NA	200	Scenery
Average	**59054.9**		**45.4**	**34.1**	**152.2**	**466.3**	

Table 6. Socioeconomic background and perceptions of users

	Jesus de Otoro	**Heredia**
N of the survey	100	100
Average income (s.d.)	US $ 245/month (223)	US $ 952/month (798)
Education		
Incomplete primary school	29 %	20 %
Complete primary school	17 %	5 %
Incomplete secondary school	25 %	24 %
Complete secondary school	21 %	9
No formal education	6 %	0 %
Post-secundary (complete or incomplete)	2 %	41 %
Water consumption		
Drink water directly form the tab	57 %	86 %
Boil water	16 %	5 %
Buy potable water	9 %	9 %
Filter water	7 %	0 %
Other purification methods	10 %	0 %
Perception on the relationship between forest cover and water		
Think more forest leads to better water quality	85 %	97 %
Think more forest leads to more water quantity	93 %	98 %
Think there is not a relationship between forest cover and water quality	7 %	3

	Jesus de Otoro	Heredia
Think there is not a relationship between forest cover and water quantity	6 %	2
Think there is a negative relationship between forest cover and water quality	6 %	0
Think there is a negative relationship between forest cover and water quantity	0 %	0
Main benefits from forests		
Water provision	57 %	68 %
Climate regulation	17 %	22 %
Watershed protection	8 %	0 %
Wood and firewood	10 %	2 %
Non-timber forest products	3 %	0 %
Beauty and biodiversity	0 %	8 %
Don't know	4 %	0 %
Perception on PES and water service		
Awareness of the scheme	43 %	21 %
Agree with the amount of the payment	72 %	92%
Think water availability has improved during the last two years	64	39
Think water quality has improved during the last two years	79	39
Think water availability has not changed during the last two years	0	61
Think water quality has not changed during the last two years	0	61
Think water availability has worsened during the last two years	21	0
Think water quality has worsened during the last two years	21	0
Overall quality of water service is good	79 %	90 %
Overall quality of water service is regular	16 %	10 %
Overall quality of water service is bad	5 %	0 %
Receive permanent water supply along the year	98 %	97 %

In Jesus de Otoro, net on-farm profits among providers and potential providers are much larger that the actual payment of the PES scheme (see tables 3 and 4). The opportunity costs in this locality are, in general, larger than the PES, regardless of the method used for estimating opportunity costs (see Table 7). This implies that alternative land uses are more profitable than the compensation that might be received from the PES scheme for maintaining forest cover. Conversely, in Heredia, net on-farm profits are very low (see Table 5). This results in an average positive "degree of compensation for opportunity costs", when it is calculated using on-farm profits as a proxy for opportunity costs. However, the other two methods shed negative values for the degree of compensation (see Table 8). This outcome is explained by the fact that providers in Heredia barely undertake any economic activity (agriculture or cattle-ranching) in their land. However, the land is relatively costly, since it has become an attractive residence area for upper-middle class people from the region and even as a place where Americans build summerhouses.

Table 7. Jesus de Otoro. Degree of compensation
(PES- Opportunity costs). US$/ha/year

Provider	Method 1 (on-farm profits)	Method 2 (fair price)	Method 3 (willingness to rent)
	US$/ha/year	US$/ha/year	US$/ha/year
1	-194.1	0.3	-37.0
2	-316.8	-43.7	-94.7
3	-644.9	-9.9	-53.6
Average	**- 385.3**	**- 17.8**	**- 61.8**

Table 8. Heredia. Degree of compensation (PES- Opportunity costs). US$/ha/year

Provider	Method 1 (on-farm profits)	Method 2 (fair price)	Method 3 (willingness to rent)
	US$/ha/year	US$/ha/year	US$/ha/year
1	43.0	-184.3	-157.0
2	-12.7	-28.6	-378.6
3	55.7	-544.3	-1,444.3
4	-40.5	-44.4	-594.4
5	51.9	-61.7	-403.1
6	-163.0	-28.1	na
7	-14.3	0.0	-89.7
8	35.6	-15.9	-52.7
9	49.0	-51.0	-251.0
10	108.1	na	na
Average	**11.3**	**-106.5**	**-421.4**

Even though Jesus de Otoro and Heredia differ considerably in their socioeconomic background, the PES schemes implemented in both cases share a number of common features:

- The impact of the PES scheme on the income of both providers and users is very low (see Tables 3, 5 and 6).
- The estimations of the opportunity costs differ considerably, depending on the method used (see Tables 3 and 5).
- In both cases, the opportunity costs calculated by means of using willingness to rent are larger than the values estimated using willingness to accept as a “fair PES”. Equally, in both cases the opportunity costs calculated by means of these proxies differ largely from the value derived from estimations of on-farm profits (see Tables 3 and 5).
- Most providers do not think that the amount they receive as payment for environmental services is “fair” (see Tables 3 and 5).
- The majority of users believe that a larger forest cover will lead to both better water quality and greater water availability (see Table 6).
- Most users think that water provision is the most important benefit from forests (see Table 6).
- Most users are not aware of the existence of the PES scheme. However, when explained, most of them agree with the scheme and the amount of the payment (see Table 6).
- A large majority of users think that the water service provided by the intermediary is good and reliable along the year (see Table 6).

4. Discussion and insights for PES design

In Jesus de Otoro, the actual PES to upstream landholders is considerable lower than the on-farm net profits that are forgone by changing land use. Additionally, the “degree of compensation” is negative, irrespectively of the method used. These results apparently contradict the economic foundation of PES schemes, since upstream landholders should demand as compensation at least the value of the forgone economic benefits from the land use alternative to forest cover. There are a number of possible interpretations of this outcome. Firstly, it is possible that the opportunity cost is overestimated by the methods we have used. This is likely if the current area covered by forest is not very suitable for agricultural production or cattle ranching (for example, because it is located in steep slopes, or in poor soils), and therefore has a marginal value for landholders. Another factor that may explain this result is that landholders obtain direct economic benefits from forests, by means of benefiting from environmental goods and services such as provision of firewood, non-timber products, shade or scenery. This would imply that forests provide indirect economic benefits to upstream landholders, which were not estimated. This explanation is supported by the results on the perception of providers on the main benefits from forests. In Jesus de Otoro, providers mentioned benefits from the forest that are related to farm production, such as firewood, soil protection and climate regulation (Table 3), while water provision was the main identified benefit from forest by downstream users (Table 6). A third explanation may be that farmers have systematically overstated their profits and willingness to rent their land, as a strategy to bargain higher PES. In-kind payments, such as training and technical advise, may also play an important role in motivating providers to adopt the PES scheme. In fact, all the providers in Jesus de Otoro stated that this kind of supporting activities constituted significant benefits from the PES scheme. An additional interpretation for explaining providers’ willingness to participate is also possible: farmers consider the payment as an small incentive, which is not significant in terms of impacts on the household’s economy and do not compensate entirely opportunity costs, but that anyway may be effective (as a “tip”) in creating incentives for the implementation of activities socially desirable, such as forest conservation or the adoption of better agricultural practices. Providers are somehow pressed by other groups of society to adopt those practices that will benefit the commons. The latent threat to incorporate upstream lands into protected areas (in case they do not adopt more water-friendly land uses) seems to have also played a role in convincing the providers to be part of the scheme in the two cases we have studied. Both locations are near protected areas, which were enacted in part for ensuring the protection of headwater areas. In fact, the PES by itself implies a redefinition of property rights on water. Therefore, ideas may easily arise on changing such property rights again in favor of downstream users. The extent to which the above-mentioned and other kind of “intangibles” may influence upstream land husbandry is an interesting area for research (Bergsma, 2000).

In Heredia, opportunity costs calculated by means of net on-farm profits are cero or negative for the majority of providers. This result is reasonable since in this location providers are relatively wealthy individuals who use their land for residence or leisure purposes. When landholders do not depend on on-farm economic activities for their livelihoods, net on-farm benefits tend to be a misleading proxy for estimating opportunity costs. Indeed, the other two methods we have used for estimating opportunity costs have shed higher values. Nevertheless, it is likely that these providers will keep in any case the remaining forest cover of their land, independently of the implementation of the PES scheme, in part because forests provide leisure and scenery to them (see Table 5). This does not hold however for the potential providers, who are strongly reluctant to participate in the PES scheme, and actually did not want to be interviewed for the present study. Paradoxically, it is probable that landholders already committed to forest conservation are the ones who participate as providers in the PES scheme in Heredia, while those upstream landholders prone to deforest will probably permanently decline to be part of it.

Urbanization is the main competing land use *vis-a-vis* forest cover in this location. This fact encompasses considerably high opportunity costs, which are probably reflected in the unwillingness of potential providers to participate in the scheme.

The fact that the amount of the payment has a small impact on both the income of providers and users has a number of implications. First, since the additional cost is marginal, users are keen to pay it and to agree with the scheme. Indeed, in both cases the acceptance of the payment by users is significantly high (see Table 6). A good reputation of the service provided by the intermediaries (see Table 6) contributes to the downstream endorsement of the scheme. Secondly, since the additional fee is very low, it does not constitute an economic incentive for reducing water demand. This fact may impose some limitations to the PES as an instrument to increase water availability. Thirdly, a small impact on the income of providers makes the PES scheme both more vulnerable to external factors (e.g. upward changes in prices of the agricultural products locally produced) and probably an ineffective tool for poverty alleviation or wealth redistribution. Furthermore, in Heredia, it is clear that the PES scheme does not work as a redistributive instrument, since upstream beneficiaries are wealthy landholders.

Both schemes are based on the local perception that water provision is one of the main benefits from forests, and the popular belief that a larger upstream forest cover leads to both better downstream water quality and greater water quantity (see Table 6). This perception seems to be common among rural dwellers in Latin America (Johnson and Baltodano, 2004) and other tropical regions of the world (Wilk, 2000). Nevertheless, the disparity between public and science perceptions on the hydrological functions of forests is well documented (Tognetti, 2004). The gaps between conventional wisdom and scientific evidence are summarized in Table 9.

Table 9. Gap between conventional wisdom and scientific evidence on the relationship between forest cover and hydrology

Conventional wisdom	Scientific evidence
Forests increase runoff	With the exception of cloud forests, runoff in forested areas is lower as compared to those with shorter vegetation
Forests increase dry season flows	This effect is site-specific. Afforestation may result in either increased or reduced dry season flows
Forests reduce peakflow	Once a new vegetation cover is well-established, peakflows no longer differ from forested conditions. The effect is of decreasing importance as the size and the number of tributaries in the basin increase. Under certain conditions, large stormflows may also emerge from forested areas.
Forests encourage more rainfall	This only holds in the case of large-scale deforestation. Local precipitation is not significantly affected by forest cover (with the exception of cloud forests)
Forests increase groundwater recharge	Groundwater recharge is affected in a similar way to seasonal flows

Summary from the reviews made by Calder (2004), Ayward (2005) and Bruijnzeel et al.(2005).

The expansion of forest cover may have a net positive impact on water availability downstream if the competing land use (e.g. agriculture) is intensive in water consumption. However, in most of the cases the empirical evidence shows that increasing forest cover leads to lower water availability downstream. For that reason, even though there is little knowledge about the effects of tropical forest cover on groundwater flow (Grip et al. 2005), PES schemes aiming to raise water availability by means of expanding forest cover should be avoided, at least as a precautionary strategy.

With regard to the relationship between forest cover and water quality, the mismatch between public and science perception is less divergent. The empirical scientific evidence on that subject may be summarized as follows (Ayward, 2005):

- Erosion increases with forest disturbance
- Deforestation likely results in larger sedimentation rates
- Forest-pasture conversion generally increases nutrient and chemical outflows, as leaching rises

These conclusions coincide very much with the public perception that forest cover and water quality are positively correlated (see Table 6). PES schemes are more likely to be effective with they tackle water quality issues. Besides, in general, at least in Latin America, water-quality problems tend to be more urgent than water scarcity.

PES schemes may face a trade-off between meeting environmental goals in the most cost-effective way and contributing to poverty alleviation (Kerr, 2002). Equally, there might be trade-offs with regard to the ability to realize different kinds of environmental goals, such improvement of water quality and biodiversity protection. These trade-offs shed some doubts on the capacity of PES schemes to work as win-win multipurpose instruments. More research is needed on the institutional and social conditions that might enable this kind of economic instruments to contribute to both a better environmental and economic performance of upstream landholders, as well as on the assumptions about the relationship between land use and the provision of environmental services on which PES schemes rely (Kaimowitz, 2005). The latter has proved to be a hard task, owing to the intrinsic complexity, context-specificity and scale-dependent nature of the hydrological functions of land use (Gautam et al., 2004; Mungai et al., 2004; van Noordwijk et al., 2004; Pattanayak, 2004; Tomich et al., 2004; Costa, 2005; Scott et al.,2005).

According to the responses of users, water availability does not seem to be a major problem in any of the cases. However, in Jesus de Otoro 57 % of users drink directly from the water pipe, compared to 86 % in Heredia (see Table 6), which suggests that there are more concerns about water quality in the former location. The PES scheme in Heredia was designed as a measure to prevent future deterioration of water sources, not as a tool for improving the condition of local water resources, which is considered to be reasonably good. Instead, the PES scheme in Jesus de Otoro worked in fact as an instrument for lessening conflicts between downstream and upstream stakeholders produced by the deterioration of water quality. In this locality, the scheme was meant to reduce water pollution, mainly by means of promoting the adoption of more environmentally friendly agricultural practices. Through the scheme, the JAPOE was able to negotiate with upstream landholders the implementation of more water-friendly land uses, even though they are not totally compensated for doing so. The PES might not be seen as a real payment, but as a “help” (*apoyo*) or tip. This case suggests that PES schemes depend upon and may help to create appropriate institutional settings for easing downstream-upstream cooperation and promoting conflict resolution. The role of the institutions dealing with the functioning of PES in watershed management is a subject that deserves considerable further research.

The JAPOE has undertaken chemical analyses of water quality in Jesus de Otoro on an annual basis since 1999. Even though there has been an improvement in several indicators of water quality, in 2004 fecal coliforms and turbidity were still above the standards for potable water. The emphasis on better environmental practices among upstream farmers makes the PES scheme in Jesus de Otoro probably more effective in achieving its main environmental goal; namely, to improve water quality. By means of creating incentives for forest protection, and therefore averting agricultural production, the scheme in Heredia may also have an impact on water quality (probably at the expense of water quantity). Nonetheless, since it is likely that the providers are not going to carry out extensive agricultural production if the scheme were not in place (indeed, 4 out of 10 producers do not report any kind of agricultural or cattle production), the real effectiveness of the scheme in accomplishing its environmental goals might be uncertain.

In both cases, technical studies did not influence noticeably the design of the PES schemes. Decisions about the design and functioning of the schemes were to a large extent negotiated politically among the stakeholders. Also, in both cases, the actual fee paid by downstream users was considerably below the estimated willingness to pay, and the payments to upstream providers were substantially lower than the opportunity cost of forest cover in Jesus de Otoro. Unfortunately, we could not estimate changes in on-farm profits produced by the adoption of better environmental practices, which would be a better measurement of opportunity cost in Jesus de Otoro. Nevertheless, our results suggest that in general the estimation of upstream opportunity cost of forest cover overestimate real willingness to accept compensation among providers. In fact, even though almost all providers did not consider "fair" the amount of the payment, they nevertheless accepted to participate in the scheme, probably because of a moral obligation to provide water plus the threat of a change in the property rights. This fact may be a source of instability of the system. Equally, estimations of downstream willingness to pay probably overestimate the fees that are politically feasible. Our impression is that the results of economic valuation were more lip service than a real input to the decision making process. The amount of the downstream fee and upstream payments finally agreed in our case studies were the result of a long, complex and political process, in which local institutions and leaderships played a significant role. The way technical issues, including economic valuations, are integrated into decision making on PES design is a subject that needs considerable further research.

Since the value of opportunity costs may vary considerably, depending on the method used, technical studies supporting PES design should conduct sensitivity analyses, based on the use of alternative methodologies. The direct and indirect benefits providers derive from forests should also be taken into account in valuation studies, otherwise opportunities costs tend to be overestimated. In practice, however, the exercise of valuing benefits from the forest may happen to be difficult, particularly for estimating the value of environmental services such as leisure and scenery.

In those cases where PES schemes are meant to improve (instead of preventing the deterioration of) the condition of water resources, systematic monitoring of the physicochemical conditions of water and communication of the results are critical activities that should be carried out by the scheme, otherwise it would be unable to demonstrate a real impact on the condition of water resources. Local participation in water quality assessment increases community empowerment and might reduce considerably the logistic costs. There are interesting examples of community-based hydrological and water quality assessments, which might be replicated (Deutsch et al., 2005).

The relationship between forest cover and water quality/quantity is normally complex (generalizations are difficult), and the gap between lay people and experts on this topic is large. Conversely, the relationship between agricultural practices and the quality of water resources is relatively easier to establish, and the gap between conventional wisdom and scientific knowledge on this subject is shorter. Therefore, PES schemes promoting the adoption of better environmental practices in agriculture are likely better technically founded and would have a higher chance to be effective in achieving the goal of improving water quality. However, the latter kind of scheme is less effective in promoting biodiversity conservation. It seems unlikely that the multipurpose objectives of PES schemes in watersheds (namely, improvement of water conditions, wealth redistribution and biodiversity conservation) can be realized simultaneously.

5. Conclusions

Even though the case studies we have assessed differ in their socioeconomic background, they share common features, such as:

- Most users hold the popular believe that forest cover is positively related to both water quality and quantity (which is not always supported by the scientific empirical evidence).
- The impact on income among both users and providers is very low
- The estimations of the opportunity costs differ considerably, depending on the method used.
- In general, the "degree of compensation" of upstream landholders is negative, which seems to contradict the economic foundation of PES schemes.
- The technical studies conducting to support the design of the schemes in fact did not influence noticeably their final structure.

In Jesus de Otoro, the PES scheme worked as a conflict-resolution instrument, facilitating the interaction between downstream and upstream stakeholders. The results suggest that trade-offs between the achievement of different environmental goals (e.g. between improvement of water quality and biodiversity conservation, or between water quality and availability) and between environmental (cost-effective improvement of water quality) and social goals (re-distribution of wealth) are likely to emerge in PES schemes. This sheds some doubts on their ability to work as multipurpose tools for environmental improvement and rural development. The adoption of environmental best practices seems to be the most effective way to ensure a causal relationship between land use changes and water quality improvement. The evaluation of opportunity costs as technical inputs for PES design should include a sensitivity analysis, since the value may vary substantially depending on the method used.

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