Payments for Environmental Services in Watersheds: Insights From a Comparative Study of three Cases in Central America

Nicolas Kosoy[1], Miguel Martinez-Tuna[1], Roldan Muradian[2] and Joan Martinez-Alier[1]

[1]Institut de Ciència i Tecnologia Ambientals (ICTA). Autonomous University of Barcelona. Building C. 08193. Bellaterra. Barcelona. Spain

[2]Development Research Institute (IVO). Tilburg University. P.O. Box 90153. 5000 LE. Tilburg. The Netherlands. roldan@uvt.nl. *Corresponding author*.

(Submitted to *Ecological Economics*, Jan. 2006).

Abstract

We have compared three cases of payments for water-related environmental 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 issues. We found that, in general, the foregone benefits from land uses alternative to forest cover are larger than the amount paid, which apparently contradicts the economic foundation of PES schemes. A number of possible explanations are explored. The results also suggest that trade-offs between different environmental and social goals are likely to emerge in PES schemes, posing 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 downstream -upstream problem solving, though at the same time they might introduce changes in social perceptions of property rights.

Key words: environmental services, watershed management, rural development, property rights, Honduras, Costa Rica, Nicaragua.

1. Introduction

Even though the theoretical foundations of payments for environmental services (PES) were set several decades ago (Coase, 1960), the practical implementation of these market-based instruments for managing natural resources has started rather recently. So far, a number of payment schemes at the watershed level have been already implemented, mainly in Latin America, allowing for 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, normally not taken into account in individual economic decisions (Pagiola et al., 2002a). The term "environmental services" refers to the provision of these positive externalities. Different types of markets for environmental services have been described in watersheds, from voluntary contractual arrangements to marketable permit systems (Tognetti et al., 2005). The three cases analyzed in the present paper constitute examples of voluntary direct payments from downstream water users to upstream providers of water-related environmental services, through the action of an intermediary agency.

By means of market transactions between downstream and upstream economic agents, PES schemes are supposed to induce upstream stakeholders to take downstream effects into account when making decisions about their own land use. This is expected to lead to larger socio-economic efficiency. Moreover, direct payments are expected to be more cost-effective in meeting environmental and 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 clearly established property rights and no transaction costs, the gains in efficiency due to the internalization of environmental externalities are independent from the direction of the payment, and also from 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 water-related service payments do not hold to the polluter-pay principle, since upstream landholders are often compensated

for avoiding/reducing negative environmental externalities. However, payment 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 the promoted land use; 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).

Direct 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. Typically, command-and-control institutions and policies 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 downstream water pollution (or scarcity) is the result of the combination of individual actions carried out by geographically disperse and heterogeneous upstream providers (Lubell et al., 2002).

In watersheds, direct use rights on forests often belong to upstream landholders. Nonetheless, forests provide a variety of environmental services to diverse stakeholders, at different geographical scales, leading to rivalry in the consumption of forest goods and services. 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 the adoption of costly actions) are supposed to be particularly effective in such circumstances (Seabright, 1993). Besides, the institutional arrangement of PES schemes may contribute to reduce transaction and monitoring costs, which are normally assumed to be critical features for solving collective action problems (Taylor and Singleton, 1993).

In tropical watersheds, 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 (often located in downstream urban

areas). Hence, PES schemes are also expected to contribute to wealth redistribution and poverty alleviation (Pagiola et al., 2002b; Pagiola et al., 2005). PES may work as multipurpose (win-win) instruments, improving the conditions of different types of natural resources at the same time (e.g. forests and water), raising awareness about the economic worth of ecosystems, and contributing to economic development (Landell-Mills, 2002).

The aim of this article is to compare three cases of payments for environmental services in watersheds, in order to draw lessons about the design, functioning, and local impacts of PES schemes. 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), San Pedro del Norte (Nicaragua) and Heredia (Costa Rica) between July and December 2004. These case studies were compared in terms of perception of different stakeholders, institutional context, opportunity costs in upstream land use, and local economic implications of the payment schemes. Stakeholders were classified into four main categories: users, providers, potential providers and intermediaries. Users are the beneficiaries of the environmental services rendered by providers. In our case studies, users are downstream water consumers in urban areas, who pay an additional fee to the PES scheme. Providers are upstream agents 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. Intermediaries are the agents mediating transfer of resources between users and providers. In our cases, the intermediaries are grassroots non-profit organizations (Jesus de Otoro and San Pedro del Norte) 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 were conducted with key informants and representatives from intermediary organizations. We also collected secondary

information on the legal, institutional and socioeconomic context. The questionnaires differed depending on the target group. 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, 7 interviews and 111 questionnaires in Costa Rica, and 9 interviews and 65 questionnaires in Nicaragua.

The opportunity costs of maintaining forest cover were estimated by means of calculating three proxy variables: a) net profits from on-farm activities that would be foregone; b) providers' willingness to accept as a "fair price" for PES; and c) the expected rent that would be obtained if the land were rented out. In theory, these three variables should converge, particularly if farmers depend on their land for ensuring their livelihoods. For the present article, net on-farm profit is defined as total production multiplied by the average price of products, minus the cost of inputs (agrochemicals, water, energy, etc.) and the cost of labor, including imputed (own) labor. The "degree of compensation" is calculated deducting the values obtained by means of the above-mentioned proxy variables from the potential or actual amount paid by the PES scheme. A negative value for the "degree of compensation" means that the PES scheme does not (or would not) compensate the opportunity cost.

In San Pedro del Norte, we assume that the three proxy variables described above applied to providers reveal information that may be used for estimating opportunity costs of forest conservation. Equally, we assume that "on-farm profits" and the "willingness to rent" of potential providers are also proxies for the opportunity costs of forest conservation. The PES scheme in Jesus de Otoro compensates upstream landholders not only for conserving the forest (as the other two schemes do), but also for adopting better environmental practices. Therefore, in this case, there are two types of opportunity costs: one related to forest conservation, and another one arising from the adoption of better environmental practices. The providers get compensated for adopting better environmental practices. In order to estimate the opportunity cost of maintaining forest cover, "on-farm profits" and the "willingness to rent" of potential providers are used as proxies. We assume that only perceptions of a "fair price" of the PES by providers might shed some information about the opportunity cost of adopting better environmental practices. The most appropriate way to estimate

the opportunity cost of adopting better environmental practices would be to calculate the foregone benefits in agriculture and cattle raising when adopting such practices. However, our methodology did not allow for a comparison of the economic performance of landholders before and after the adoption of such practices.

In Heredia, urbanization is the most likely alternative land use to forest cover, and the livelihood of providers does not depend on agriculture or cattle raising. Accordingly, we consider that "on-farm profits" is not a good proxy for the opportunity cost of forest conservation. Therefore, we assume that only "willingness to rent" and "fair price" shed meaningful information about opportunity costs in this case. Potential providers in Heredia were not willing to take part in the research, clearly being opposed to the PES scheme. For that reason, they are not included in the results.

3. Results

3.1 Overall 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 about 5,200 inhabitants. The water consumed in this town comes from the watershed of the Cumes River. The area of the watershed is 3,180 ha, of which 70 % is covered by forest. Part of the watershed is within the Natural Reserve Montecillos (protected area). Its highest elevation of this watershed is of 2,200 m.a.s.l. Coffee plantations are very common in the upstream area and the main economic activity in the region is agriculture. The local Council for Administration of Water and Sewage Disposal (JAPOE), a grassroots organization, is in charge of managing water provision and sanitation in town. The creation of JAPOE was a response to serious water problems at the beginning of 1990s. This organization took over the management of water and sanitation services from the Municipality. The authorities of JAPOE are elected in general assemblies in 10 different sectors of the town, thus it constitutes a decentralized and participatory institution for water and sanitation management. In 1996, an expansion of upstream cultivated areas, mainly coffee, increased the pollution levels in the surface waters, also used for drinking water. This led to severe conflicts between downstream water consumers and upstream landholders. In 2001, the Program for Sustainable Agriculture in Hillsides of Central America (PASOLAC), financed by the Swiss international cooperation, supported

technically JAPOE to create a payment scheme for environmental services, and provided the seed capital. At the time the fieldwork was conducted, the scheme offered payments to only 4 providers and covered about 22 ha. Later, the coverage has been expanded to 18 providers and 74 ha. We could interview 3 out of the 4 providers. The scheme is meant to promote both the adoption of better environmental practices and the conservation of forests, and it is expected to cover up to 200 ha in the future. The amount of the payment depends on the number of "better practices" adopted and on the type of forest protected. The payment amounts are summarized in Table 1.

INSERT TABLE 1 ABOUT HERE

The land uses 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

JAPOE charges water fees to 1,269 households. Water users 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 scheme aims primarily to improve water quality. Water availability is not a significant problem in the region.

The creation of the scheme was supported by three technical studies, including 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 scheme was not clear-cut. For example, the actual PES fee was only 3.6 % of the water users´ estimated willingness to pay. The final amount of the fee was decided through voting of representatives from the different water sectors in town. The overall cost of design and initial setup 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 Virilla River watershed. The area of the watershed providing water to Heredia is approximately 11,340 ha, and its highest elevation is of 2250 m.a.s.l. This PES scheme was designed and managed by ESPH S.A, a public local enterprise for water provision and sanitation. Users are 48,667 households. Part of the National Park "Braulio Carrillo" is located in this watershed. About 34% of the Virilla watershed is covered by forest. In 2002, the PES scheme was created in order to avoid deterioration of the upstream area of the watershed, where water sources are located. The scheme prioritized 1,062 ha in the upstream area, from which 415 ha are currently part of it. The main goal of the scheme is to prevent deterioration of water quality, since the city currently does not seem to face water scarcity. At the time the fieldwork was conducted, there were 10 providers, and all were interviewed. The scheme has identified 29 landholders as potential providers. However, none of them were willing to participate in this study.

The area where the PES is implemented has also become a high-status residence (or leisure) place for well paid professionals, who normally work in downstream urban areas, or for foreigners. All the providers interviewed, except one, held a university degree. Users paid 0.008 US$/$m^3$ to the PES scheme, which was about 6% of the normal water fee for households. ESPH has also established an agreement with a beverage company consuming local water resources (Florida Ice & Farm Co) for allocating additional resources to the PES scheme. Table 1 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 products
- Forest conservation: no forest conversion to agriculture or cattle ranching
- Reforestation (optional)

In 2003, the scheme also invested a considerable part of the fund for land acquisition in the upstream area. As 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 fee charged to users was decided on political grounds, and it is considerable lower than their estimated willingness to pay. The cost of the initial setup of the scheme was about 32,000 US$.

San Pedro del Norte, Nicaragua

The "Paso de Los Caballos" watershed is located in the western region of Nicaragua. It has a tropical climate characterized by a strong dry season, and its area is about 741 ha, 21 % of which is covered by forests. The main economic activities in the region are agriculture and cattle ranching. This watershed supplies water to 125 households in San Pedro del Norte. Dwellers of this locality face considerable water problems, both in terms of quality and availability. Locally, these problems are often attributed to the highly degraded forests. This PES scheme shares many features with that in Jesus de Otoro. The Water Committee currently in charge of the PES was created to take over water provision and sanitation, as a local response to the inefficient service previously provided by a public enterprise. As in Jesus de Otoro, PASOLAC introduced the idea of the PES scheme, and provided a seed fund for background technical studies and setting up the system in 2003. Previous to the establishment of the PES, PASOLAC sponsored the visit of a delegation from the local Water Committee and the Municipality to learn from the Jesus de Otoro experience. At the time the fieldwork was conducted, 5 upstream landowners and 39 ha were part of the PES scheme.

125 households contribute with US $ 0.31/month to the PES scheme. As in Jesus de Otoro, the fee was decided in a participatory way in the Water Committee, and it differs considerably from the estimations of willingness to pay made by the technical reports. Each provider receives approximately US $26/ha/year. This amount was set by negotiations between the Water Committee and each of the providers. The cost of the initial setup was about US$10,000, some of which go to current payments. The scheme promotes the following land uses:

- Conserve and manage the forested area
- Prevention and control of forest fires

- Restricted timber extraction
- Implementation of a management plan
- Livestock raising is not allowed
- Subsistence crop farming is allowed only in one hectare per provider, without the use of pesticides and agro-chemicals

3.2 Quantitative analysis

3.2.1 Providers and potential providers

The socioeconomic characteristics of the three places differ noticeably. Providers and potential providers in Jesus de Otoro and San Pedro del Norte are relatively poor peasants who rely to a large extent on their land for their livelihoods. Their subsistence farming systems are characterized by low or even negative, on-farm profits. In Heredia, providers are wealthy professionals whose income does not depend on their land (see Tables 2 and 3). Miranda et al. (2003) also found that the main beneficiaries of PES schemes in the Virilla watershed are wealthy landholders, as in other cases in Costa Rica (Zbinden and Lee, 2005).

INSERT TABLES 2 AND 3 ABOUT HERE

The amount received from the PES scheme constitutes less than 2% of gross annual income for most providers, in the three cases (see Table 2). Most providers do not think that the amount they receive as payment for environmental services is "fair". Both providers and potential providers in San Pedro del Norte should state similar values for "net on-farm profits", "fair PES" and "willingness to rent", since the expected rent from land should be at least the actual benefits from farming activities. Equally, providers in Heredia should report similar "fair PES" and "willingness to rent". Nonetheless, the above-mentioned values differ noticeably. This means that the estimation of the opportunity costs differ considerably, depending on the method used, and the assumptions adopted.

In Jesus de Otoro, we assume that providers' perception on "fair PES" should reflect the opportunity costs of adopting better environmental practices, since these providers are actually paid for adopting such practices. We have also calculated the opportunity cost of forest conservation in Jesus de Otoro among potential providers. Table 4

shows averages of actual or potential “degree of compensation” by the PES schemes, according to different methods for estimating opportunity costs in the three case studies. In general, we found that opportunity costs were larger than the actual or potential payment, regardless of the method used.

INSERT TABLE 4 ABOUT HERE

3.2.2 Users

Notwithstanding differences in their socioeconomic background (see Table 5), users in the three cases share a number of common features. The results of the information gathered from users may be summarized as follows:

INSERT TABLE 5 ABOUT HERE

- The impact of the PES scheme on the income of users is low
- Most of them consume water directly from the tap, which means that they are vulnerable to water quality problems
- The majority of users share the belief that a larger forest cover will lead to both better water quality and greater water availability
- Most users perceive that water provision is the most important benefit from forests
- Most users are not aware of the existence of the PES scheme. When the scheme is explained, the majority of users in Heredia and Jesus de Otoro agree with the amount of the payment. However, only 29 % of the surveyed users in San Pedro del Norte agree with such amount.
- A large majority of users in Jesus de Otoro and Heredia think that the water service provided by the intermediary is good and reliable around the year, while most users in San Pedro del Norte consider that the overall quality of the service is bad
- The majority of users in both Jesus de Otoro and San Pedro del Norte perceive that water quality and availability have improved during the last two years, while in Heredia most users consider that the quality of the service has not changed during the last two years (it has remained good).

4. Discussion and insights for PES design

We have found that, in general, the degree of compensation for forest conservation is negative, irrespectively from the estimation method. Unfortunately we were unable to estimate the opportunity costs for the adoption of better environmental practices in Jesus de Otoro, which would probably shed interesting insights on this issue. We expect that it is easier to fully compensate for the opportunity cost of adopting better practices than for protecting the forest or reforesting. Our empirical findings suggesting that the amount of the payment is below the opportunity cost of forest conservation apparently challenge the economic foundation of PES schemes, since upstream landholders should demand as compensation at least the value of the foregone economic benefits. There are a number of possible interpretations for this outcome. Firstly, if one adopts the proposition that providers are rational economic actors, it is possible to assume that as far as providers participate voluntarily in the scheme their opportunity costs are indeed being compensated; otherwise they would simply decline to do so. If this is the case, negative "degrees of compensation" are a methodological artifact, which might be generated by variety of causes. For example, it is possible that the opportunity cost of forest protection is overestimated by "on-farm profits". This is likely if the current area covered by forest is not very suitable for agricultural production or cattle raising (for example, because it is located in steep slopes, or in poor soils), and therefore has a low value for landholders. Another factor that may explain this result is that landholders obtain economic benefits from forests' environmental goods and services, such as provision of firewood, non-timber products, shade or scenery. These direct or indirect economic benefits provided by forest to upstream landholders were not estimated in this study. However, providers mentioned as main forests benefits, goods and services that are related to farm production, such as firewood, soil protection and climate regulation (see Table 2), while water provision was the main forest benefit identified by downstream users (see Table 5). A third explanation may be that farmers have systematically overstated their profits, willingness to rent their land and perceptions of a "fair" price for PES, as bargain strategies for higher payments. Furthermore, in-kind payments, such as technical training, may also play an important role in motivating providers to adopt the PES scheme, even

though opportunity costs are not fully compensated. In fact, all providers in Jesus de Otoro stated that this kind of supporting activities constituted significant benefits from the PES scheme.

Nonetheless, if providers are assumed to be agents with "bounded rationality", other types of explanations may be also explored. For example, an alternative interpretation might be that providers consider the payment as a small incentive, not significant in terms of the household economy. They perceive the payment as a "support" (some providers used explicitly the word "*apoyo*"), namely a token incentive to implement activities already socially desirable. On the one hand, local social and cultural features, such as religious or social habits, environmental awareness and education programs, may play a role in inducing forest conservation, even though it may be economically inefficient from the individual point of view. On the other hand, providers are somehow pressed by other groups of society to adopt practices benefiting the commons. Property rights might in theory be clearly defined but in fact, environmental conflicts are about who enjoys and who pays for the environment. For instance, the latent threat to incorporate upstream lands into protected areas seems to have played a role in convincing providers in Jesus de Otoro and Heredia to be part of the scheme. There lands are near protected areas that were established in part for ensuring the protection of headwaters. 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). Due to our methodological constraints, we think that our results suggesting that the PES schemes do not compensate totally the opportunity costs of forest conservation are not yet conclusive, but have a heuristic value. They may shed new light for developing working hypotheses that might be tested in future research. The calculation of opportunity costs among landholders in developing countries is a daunting task, since it depends on a large number of assumptions, landholders usually do not register their transactions, and strategic answers are unavoidable.

In Heredia, it is likely that providers will keep the remaining forest cover on their land, independently of the implementation of the PES scheme. This does not hold however for the potential providers, who are strongly reluctant to participate in the

PES scheme. Paradoxically, it is probable that landholders already committed to forest conservation are the ones who participate as providers in the PES, while those upstream landholders prone to deforestation and urbanization will possibly permanently decline to be part of it. The cost-effectiveness of the payments would be doubtful if this is the case. The evaluation of PES *vis-à-vis* alternative tools for downstream-upstream concerted action is a critical point to take into account in the initial design of PES schemes. If future providers are already strongly committed to keep the promoted land uses, then direct payments are probably not the most suitable mechanism for achieving the expected environmental goals.

The fact that the payment has a small impact on the income of both providers and users has a number of implications. First, since the additional cost is low, users are keen to pay it and to agree with the scheme, as in Heredia and Jesus de Otoro. The lower acceptance among users in San Pedro may be explained in part by a bad reputation of the local water service, a larger share of the PES fee to users' average income (see Table 4) and the recent implementation of the scheme. Secondly, since the additional fee is very low, it does not constitute an economic incentive for reducing water demand. This may impose some limitations on 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 and probably an ineffective tool for poverty alleviation or wealth redistribution in cases such as San Pedro del Norte and Jesus de Otoro. This is a critical issue since these instruments, although not having poverty reduction as their primary concern, are expected to contribute also to economic development and poverty alleviation (Grieg-Gran et al., 2005).

The analyzed schemes are based on the local perception that water provision is one of the main forest benefits, and the popular belief that larger upstream forest cover leads to better downstream water quality and greater quantity (see Table 5). 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 scientific perceptions on the hydrological functions of forests is well documented (Tognetti, et al. 2004). The gap between conventional wisdom and scientific evidence is summarized in Table

6. The relationship between land uses and hydrological dynamics is probably the most critical technical challenge of water-related PES schemes.

INSERT TABLE 6 ABOUT HERE

The expansion of forest cover may have a net positive impact on downstream water availability if the competing land use (e.g. agriculture) is intensive in water consumption. However, in most cases the empirical evidence shows that enlarging 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 rise water availability by means of expanding forest cover should be avoided, at least as a precautionary strategy. The assumptions about the relationship between land use and water-related environmental services are decisive for evaluating the cost-effectiveness of these instruments, and for establishing the direction of the payment. Indeed, a scheme in South Africa applies an opposite logic to those here described since it levies a charge on commercial afforestation areas, in order to compensate for the capture of water by some types of trees (Katilla and Puurstjärvi, 2004).

Regarding the relationship between forest cover and water quality, there is a smaller mismatch between public and science perceptions. 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 5). PES schemes are more likely to be effective when they tackle water quality problems. There is less uncertainty and less divergence between public expectations and scientific evidence on the relationship between land use and water quality.

Probably the emphasis on the adoption of better environmental practices among upstream farmers makes the PES scheme in Jesus de Otoro comparatively more cost-effective in achieving its main environmental goal; namely, to improve water quality. By creating incentives for forest protection, and therefore averting agricultural production (or other land uses), the schemes in Heredia and San Pedro may also have an impact on water quality, but possibly at the expense of reducing downstream water availability. More research is needed to test the assumptions on the relationships between land use and the provision of environmental services on which PES schemes rely upon (Kaimowitz, 2005). This will be a hard task owing to the intrinsic complexity, context-specificity, and scale-dependent nature of the hydrological functions of different land uses (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). However, there are interesting examples of community-based hydrological and water quality assessments (Deutsch et al., 2005), which might be replicated for reducing the operational costs of evaluating the effects of PES schemes on the condition of water resources.

The hydrological evidence summarized above suggest that there might be trade-offs in relation to the ability of PES to achieve different kinds of environmental goals, such as improvements of water quality, water availability and biodiversity protection. Equally, PES schemes may also face a trade-off between meeting environmental goals in the most cost-effective way and contributing to poverty alleviation (Kerr, 2002). Indeed, in the cases we have analyzed, the effects on upstream income are in general negligible, or the PES payments go to wealthy providers (Heredia), or they are made by users who are poor. These trade-offs shed some doubts on PES schemes as win-win and multipurpose instruments. Nonetheless, some of the information gathered supports the view that this type of markets may contribute to solve social conflicts. Indeed, in Jesus de Otoro, the PES scheme worked out as a tool for lessening conflicts between downstream and upstream stakeholders. This case suggests that PES schemes may aid to create institutional settings for easing downstream-upstream cooperation and promoting conflict resolution. In Jesus de Otoro, social asymmetries were not large to start

with. In other cases, PES schemes may seem to announce permanent land rights changes, and therefore perhaps they will face resistance by some social actors.

We have also found that preliminary technical studies did not noticeably influence the design of the selected PES. Design decisions and the functioning of PES schemes were to a large extent the result of a complex social process, involving interactions between different stakeholders, rather than the outcome of a technical assessment. Our results also suggest that in general the calculation of upstream opportunity cost of forest cover based on on-farm profits overestimates actual willingness to accept compensation among providers. Equally, calculations of downstream willingness to pay probably overestimate politically and socially feasible fees. In our cases, the users´ payments were significantly below the estimated willingness to pay. Our impression is that economic valuations were more lip service than a real input to the decision making process. The payments from downstream users to upstream providers were the result of a long and complex negotiation process, in which local institutions and leadership played significant roles. When market transactions between downstream and upstream stakeholders are feasible, paying attention to social relations, perceptions, bargaining power, property rights and institutional aspects are probably more useful inputs to PES design than mere economic valuations. The social embeddedness of markets for environmental services and the social transformations triggered by them, are very relevant topics for future research.

Acknowledgements

This research was financed by Foundation BBVA. We would like to thank all the communities for their help and support during our field work. We would also like to thank the comments and criticisms from an anonymous reviewer.

References:

Ayward, B. 2005. Land use, hydrological function and economic valuation. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Bergsma, E. 2000. Incentives of land users in projects of soil and water conservation, the weight of intangibles. GeoJournal 50: 47-54.

Bruijnzeel, L.A., Bonell, M., Gilmour, D. and D. Lamb. 2005. Forests, water and people in the humid tropics: an emerging view. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Calder, I.R. 2004. Forests and water: Closing the gap between public and science perceptions. Water Science and Technology 49 (7): 39-53.

Coase, D. 1960. The problem of social cost. Journal of Law and Economics 3:1-44.

Costa, 2005. Large-scale hydrological impacts of tropical forest conversion. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Deutsch, W., Busby, Orprecio, J., Bago-Labis and E. Cequiña. 2005. Community-based hydrological and water quality assessments in Mindanao, Philippines. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Ferraro, P. and A. Kiss. 2002. Direct payments to conserve biodiversity. Science 298: 1718-1719.

Gautam, A., Shivakoti, G. and E. Webb. 2004. Forest cover change, physiography, local economy, and institutions in a mountain watershed in Nepal. Environmental management 33 (1): 48-61.

Gibson, C., McKean and E. Ostrom (Eds). 2000. Communities, Institutions and Governance. MIT press. USA.

Grieg-Gran, M., Porras, I. and S. Wunder. 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. World Development (33): 2: 237-253.

Grip, H., Fritsch, J-M, and L. Bruijnzeel. 2005. Soil and water impacts during forest conversion and stabilization to new land use. In: Bonell, M. and L.

Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Johson, N. and M.E. Baltodano. 2004. The economics of community watershed management: some evidence from Nicaragua. Ecological Economics 49: 57-71.

Kaimowitz, D. 2005. Useful myths and intractable truths: the politics of the link between forests and water in Central America. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Katilla, M. and E. Puustjärvi. 2004. Markets for forest environmental services: reality and potential. Unasylva 219 (55): 53-58.

Kerr, J. 2002. Watershed development, environmental services, and poverty alleviation in India. World Development 30 (8): 1387-1400.

Landell-Mills, N. 2002. Developing markets for forest environmental services: an opportunity for promoting equity while securing efficiency?. Philosophical Transaction of the Royal Society 360: 1817-1825.

Landell-Mills, N. and I. Porras. 2002. Silver bullet or fools' gold?A global review of markets for forest environmental services and their impact on the poor. IIED. London.

Lubell, M., Schneider, M., Scholz, J. and M. Mete. 2002. Watershed partnership and the emergence of collective action institutions. American Journal of Political Science 46 (1): 148-163.

Mayrand, K. and M. Paquin. 2004. Payments for Environmental Services: A Survey and Assessment of Current Schemes. Report elaborated by UNISFERA for the Commission for Environmental Cooperation of North America.

Miranda, M., Porras, I. and M.L. Moreno. 2003. The Social Impacts of Payments for Environmental Services in Costa Rica: A Quantitative Field Survey and Analysis of the Virilla Watershed. International Institute for Environment and Development (IIED). London.

Mungai, D., Ong, C., Kiteme, B., Elkaduwa, W. and R. Sakthivadivel. 2004. Lessons from two long-term hydrological studies in Kenya and Sri Lanka. Agriculture, Ecosystems and Environment 104:135-143.

Nathan, D. and G. Kelkar. 2001. Case for local forest management, environmental services, internationalization of costs and markets. Economic and Political Weekly 2835-2845.

Noordwijk, M. van, Poulsen, J. and P. Ericksen. 2004. Quantifying off-site effects of land use change: filters, flows and fallacies. Agriculture, Ecosystems and Environment 104: 19-34.

Ostrom, E., Dietz, T., Dolsak, N., Stern, P., Stovich, S. and E. Weber (Eds). 2002. The Drama of the Commons. National Academy Press. Washington.

Pagiola, S. 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. World Development 33 (2): 237-253.

Pagiola, S. Landell-Mills, N. and J. Bishop. 2002a. Market-based mechanisms for forest conservation and development. In: Pagiola, S. Landell-Mills, N. and J. Bishop (Eds). Selling Forest Environmental Services. Earthscan. London.

Pagiola, S. Landell-Mills, N. and J. Bishop. 2002b. Making market-based mechanisms work for forests and people. In: Pagiola, S. Landell-Mills, N. and J. Bishop (Eds). Selling Forest Environmental Services. Earthscan. London.

Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ramirez, E., Rosales, M. and J.P. Ruiz. 2004. Paying for biodiversity conservation services in agricultural landscape. Environment Department Papers No. 96. World Bank.

Pattanayak, S. 2004. Valuing watershed services: concepts and empirics from Southeast Asia. Agriculture, Ecosystems and Environment 104: 171-184.

Rosa, H., Kandel, S. and L. Dimas. 2004. Compensation for environmental services and rural communities: lessons from the Americas. International Forestry Review 6 (2): 187-194.

Scott, D., L. Bruijnzeel and J. Mackensen. 2005. The hydrological and soil impacts of forestation in the tropics. In: Bonell, M. and L. Bruijnzeel (Eds). Forests, Water and People in the Humid Tropics. Cambridge University Press/UNESCO.

Seabright, P. 1993. Managing local commons: Theoretical issues in incentive design. Journal of Economic Perspectives 7(4): 113-134.

Taylor, M. and S. Singleton. 1993. The communal resource: transaction costs and the solution of collective actions problems. Politics and Society 21 (2): 195-214.

Tognetti, S., Ayward, B. and G. Mendoza. 2005. Markets for watershed services. In: Anderson, M.(ed). Encyclopedia of Hydrological Sciences. John Wiley & Sons. UK.

Tognetti, S., Mendoza, G., Ayward, B., Southgate, D. and L. Garcia. 2004. A Knowledge and Assessment Guide to Support the Development of Payments Arrangements for Watershed Ecosystem Services. Report prepared for the World Bank Environment Department.

Tomich, T., Thomas, D. and M. van Noordwijk. 2004. Environmental services and land use change in Southeast Asia: from recognition to regulation or reward?. Agriculture, Ecosystems and Environment 104: 229-244.

Warner, K., Huang, M. and D. Middleton. 2004. Financial Incentives to Communities for Stewardship of Environmental Resources: feasibility Study. Report prepared by Winrock for USAID.

Wilk, J. 2000. Local perceptions about forests and water in two tropical catchments. GeoJournal 50: 339-347.

Zbinden. S. and D. Lee. 2005. Paying for environmental services: An analysis of participation in Costa Rica's PSA program. World Development 33(2): 255-272.

Table 1. Amounts paid to providers (US $/ha/year)

Jesus de Otoro			
Forest conservation	*Primary forest*	*Secondary forest*	*Young forest*
	5.5	4.1	2.8
Environmental practices	*2 practices adopted*	*3 practices*	*4 practices*
Short cycle crop	5.5	8.3	11
Permanent crop	8.3	11	13.8
Agroforestry	11	13.8	16.6
Heredia			
Forest conservation	*Reforestation, first year*	*Reforestation, second year*	*Reforestation, third to fifth year*
51	124	100	67
San Pedro del Norte			
Forest conservation			
26.6			

Table 2. Providers

Provider	Gross income (on-farm and off-farm)	PES (in a year) to gross income	PES/area	Net on-farm profits	"Fair PES"	Willingness to rent	Main benefit from forest
	US$/year	*%*	*US$/ha/year*	*US$/ha/year*	*US$/ha/year*	*US$/ha/year*	
Jesus de Otoro							
1	7,625	0.4	15.9		15.6		Wood
2	5,374	1.2	11.9		55.6		Soil protection
3	12,059	0.6	9.5		19.4		Climate regulation
Average	**8,353**		**12.4**		**30.2**		
San Pedro del Norte							
1	4,562	0.03	26.4	106	89	133	Wood
2	3,005	0.02	18.7	423	266	531	Water
3	360	0.15	26.6	-39	133	n.a.	Wood
4	863	0.08	26.6	-65	89	354	Climate regulation
5	1,329	0.03	33.1	206	156	319	Water
Average	**2,024**		**26.3**	**126**	**147**	**334**	
Heredia							
1	60,000	0.7	43.0		227	200	Scenery
2	90.377	0.5	21.4		50	400	Climate regulation
3	13,800	1.6	55.7		600	1,500	Water
4	171,573	1.2	55.6		100	650	Biodiversity
5	19,091	9.5	51.9		114	455	Scenery
6	13,398	6.6	52.1		80	n.a.	Leisure
7	33,679	1.3	30.3		30	120	Water
8	4,522	6.9	52.3		68	105	Scenery
9	132,000	0.1	49.0		100	300	Scenery
10	52,110	21.8	42.2		n.a.	200	Scenery
Average	**59,055**		**45.4**		**152**	**466**	

Table 3. Potential providers

Potential Provider	Gross income (on farm and off-farm) US$/year	Net on-farm profits US$/ha/year	Willingness to rent US$/ha/year
Jesus de Otoro			
1	1,353	262	79.4
2	3,157	603	23.8
3	2,957	1079	79.4
4	2,267	-78	12.7
5	1,165	231	44.1
6	836	384	14.7
7	1,252	-189	111.1
8	2,822	192	27.6
9	3,588	287	33.9
Average	**2,155**	**308**	**47.4**
San Pedro			
1	1,223	76	53
2	2,321	297	62
3	1,485	-9	62
4	301	206	266
Average	**1,333**	**142.5**	**111**

Table 4. Degree of compensation

(PES- Opportunity cost). Average. US$/ha/year

	Method 1 (on-farm profits)	Method 2 (fair price)	Method 3 (willingness to rent)
Jesus de Otoro			
Providers[a]		-19	
Potential Providers[b]	-302		-42
San Pedro			
Providers	-100	-120	-308
Potential Providers	-116		-84
Heredia			
Providers		-107	-421

[a] Opportunity cost of better environmental practices

[b] Opportunity cost of forest conservation (assuming a PES equal to 5.52 US$/ha/year)

Table 5. Socioeconomic background and perceptions of users

	Jesus de Otoro	San Pedro	Heredia
N of the survey	100	56	100
Average income, US$/month (s.d.)	245	66	952
Payment to the PES scheme, US$/household/month (* US$/m3)	0.06	0.31	0.008*
Education (%)			
Incomplete primary school	29	45	20
Complete primary school	17	10	5
Incomplete secondary school	25	9	24
Complete secondary school	21	18	9
No formal education	6	16	0
Post-secondary (complete or incomplete)	2	2	41
Water consumption (%)			
Drink water directly form the tap	57	98	86
Boil water	16	0	5
Buy potable water	9	2	9
Filter water	7	0	0
Other purification methods	10	0	0
Perception on the relationship between forest cover and water (%)			
More forest leads to better water quality	85	91	97
More forest leads to more water quantity	93	100	98
Lack of relationship between forest cover and water quality	7	7	3
Lack of relationship between forest cover and water quantity	6	0	2
Negative relationship between forest cover and water quality	6	2	0
Negative relationship between forest cover and water quantity	0	0	0
Main benefits from forests (%)			
Water provision	57	54	68
Climate regulation	17	16	22
Watershed protection	8	2	0
Wood and firewood	10	21	2
Non-timber forest products	3	2	0
Beauty and biodiversity	0	0	8
Don’t know	4	5	0
Perception on PES and water service (%)			
Awareness of the scheme	43	32	21
Agree with the amount of the payment	72	29	92
Water availability has improved during the last two years	64	59	39
Water quality has improved during the last two years	79	55	39
Water availability has not changed during the last two years	0	41	61

Water quality has not changed during the last two years	0	45	61
Water availability has worsened during the last two years	21	0	0
Water quality has worsened during the last two years	21	0	0
Overall quality of water service is good	79	11	90
Overall quality of water service is regular	16	30	10
Overall quality of water service is bad	5	59	0
Receive permanent water supply along the year	98	50	97

Table 6. Forest cover and hydrology: conventional wisdom and scientific evidence

Conventional wisdom	Scientific evidence
Forests increase runoff	With the exception of cloud forests, runoff in forested areas is lower than in 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 peakflows	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).