Valuing environmental goods and services: is it a tool for increasing the effectiveness of PES schemes in developing countries?

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Abstract

Payments for ecosystem service (PES) schemes have spread all over developing countries in the last twenty years or so. These services are usually indirect uses of the natural capital by human beings. Therefore, PES schemes often have high opportunity costs in terms of foregone uses of goods and services offered by the environment. It is within this scope that economic evaluation of environmental goods and services plays a role. Economic valuation may illuminate the decision making process in order to achieve an efficient allocation of environmental goods and services. It is surprisingly, therefore, that very few studies have attempted to analyze how (and if) economic valuation is really contributing for the selection of really efficient PES projects. This lack of investigative works is even more surprisingly when one considers that economic valuation procedures have many limitations and have received strong criticisms.

This article intends to fill, at least in part, this gap in knowledge. We surveyed articles and studies that report application of economic environmental valuation procedures in PES schemes. Each one of them was evaluate in terms of its methodological procedures for valuation. We paid special attention to data collection and analysis, to theoretical robustness of its procedures and to the aggregation of estimated value. In the next stage of our research we scrutinize how these estimates had been incorporated into PES schemes, in particularly in the assessment phase of these schemes. Finally, we assess differences between value estimates beforehand and actual price observed afterwards for ecosystem services supplied under PES schemes. We used empirical data from Brazil and other Latin American countries, particularly those in the Amazon Basis.

Our results reveal a frequent overestimation of the values of ecosystem services calculated through the use of economic valuation methods. Values have been estimated by production function methods (opportunity cost, preventive expenditures, recovering cost or dose-response methods). As a consequence, estimated values reflect much more willingness to accept compensation by supplier and much less willingness to pay by consumer of these ecosystem services. Besides this distance between supply and demand, application of valuation methods did not account for problems such as uncertainty, risks, and lack of information. All these limitations have lead to wrong decision-making.

Through valuation, one becomes not only aware of the importance of environmental services to society, but also of the social costs arising from their destruction. Thus economic valuation makes it possible for agents to choose rationally between the conservation and alternative land uses. Environment economic valuation is also important to quantify benefits derived of each available alternative. Therefore, it allows comparison between costs and benefits of various ecosystem goods and services. However, these methods still have disadvantages and shortcomings In this sense, economic valuation should not be abandoned, but rather improved, after all it is essential in the creation of programs for payments for environmental services.

Keywords: economic valuation, payment for ecosystem services (PES), valuation methods, environmental costs and benefits.

Initial Comments

In a recent and as usual provocative paper, Sagoff (2011) argues that the "ecosystem services" project is bound to fail in its attempt to substitute an *in natura* calculus of value for the artifice of market price. We cannot agree more. The term "ecosystem services' has emerged in the early 1980s to describe a framework for structuring and synthesizing biophysical understanding of ecosystem processes in terms of human well-being. Almost simultaneously, there has been an emergence (or resurrection) of attempts to develop more "objective" assessments of ecosystem contributions to human welfare that would not suffer from the "subjectivism" of the exchange value of an ecosystem service (its "price") that is constantly negotiated in view of market conditions, as it is for any other good or service.

Ecologically-minded economists have followed Odum (1967) to apply thermodynamic principles to understand economic value in terms of units of solar energy, photosynthesis, or net primary productivity – the energy environment account alternative. Also the ecological footprint has emerged as a measure of humanity's demand on nature. Conceived in 1990 by Mathis Wackernagel and William Rees at the University of British Columbia, it measures how much land and water area a human population requires to produce the resource it consumes and to absorb its carbon dioxide emissions, using prevailing technology. It was not a very large step forward to develop the carbon footprint, a measure of the impact human activities upon the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for electricity, heating and transportation, etc.

These "objective standardized units of account to measure the value of ecosystem services to society" are, we argue, weak instruments to illuminate decision making of "persuade those stakeholders and interest groups who are used to solving problems by applying dispersed, diffused, partial, particular, and local kinds of information." (Sagoff, 2011, p. 498). It seems to us that the Austrian economist Friedrich A. Hayek was corrected when inveighed against scientists who tried to apply "objective" measures of biophysical value to plan economic production in the beginning of the 1940s. Hayek (1942–44, p. 53) argued, "Neither a 'commodity' nor an 'economic good', nor 'food' nor 'money' can be defined in physical terms but only in terms of views people hold about things."

Our working hypothesis is that Hayek was correct and, therefore, an "ecosystem service" cannot be defined in physical terms but only in relation to the views people hold about things, for example, about what they and other people may want at a given time, about what is likely to be scarce or plentiful, about the prices of substitutes and of complementary goods, and about political, social, and economic conditions. However, if ecosystem services are the economically valuable functions that ecosystems provide to humans, these functions can generate both marketed and non-marketed benefits.

In this context, Spash (2008) observed that there has been an increase in the desire of conservation biologists and ecologists for biodiversity and ecosystems functions to be expressed as part of a mainstream economics of value. The need for monetary valuation of non-marketed environmental services has been voiced internationally in recent years. This has coincided with the spreading of payments for ecosystem service (PES) schemes all over developing countries. These services are usually indirect uses of the natural capital by human beings. Therefore, PES schemes often have high opportunity costs in terms of foregone uses of goods and services offered by the environment. It is within this scope that economic evaluation of environmental goods and services seems to play a role. It is surprisingly, therefore, that very few studies have attempted to analyze how (and if) economic valuation is really contributing for the selection of really efficient PES projects.

This lack of investigative works is even more surprisingly when one considers that economic valuation procedures have many limitations and have received strong criticisms. This article intends to fill, at least in part, this gap in knowledge. We surveyed articles and studies that report application of economic environmental valuation procedures in PES schemes. Each one of them was evaluated in terms of its methodological procedures for valuation. We paid special attention to data collection and analysis, to theoretical robustness of its procedures and to the aggregation of estimated value. In the next stage of our research we scrutinize how these estimates had been incorporated into PES schemes, in particularly in the assessment phase of these schemes. Finally, we assess differences between value estimates beforehand and actual price observed afterwards for ecosystem services supplied under PES schemes. We used empirical data from Brazil and other Latin American countries, particularly those in the Amazon Basis.

Basis of Economic Valuation

The Payments for ecosystem services (PES) schemes are compensations for environmental services such as carbon sequestration, as is in Costa Rica and Ecuador, biodiversity conservation, as in Bolivia, and as forest conservation to guarantee water supply, such as in Guatemala, Honduras, Brazil, among others. Usually these are forest related activities that receive compensation for actions leading to forest conservation, reforestation, and adoption of agricultural practices that promote soil and water conservation and reduce water pollution (Kiersch, et al., 2005). PES initiatives can be at local, regional or national level; they may be exclusively private deals or arrangements that have strong public participation, with or without external support from private, public or multilateral sources (Kiersch, et al., 2005).

PES schemes should not be confused with social programs such as income employment generation, income redistribution or poverty reduction, in spite of the fact that they may even have these side-effects. A payment for an environmental service is not a donation or a charity but do promote money transference and stimulate a change in behavior (Nogueira & Hasenclever, 2012). The payment for a service that had been considered a free good for decades may stimulate an environmentally responsible behavior by those who directly or indirectly have used it.

One usually tends, on the other hand, to see PES schemes as the solution to environmental problems, such as deforestation and pollution. In fact, PES schemes have the potential to prevent environmental degradation and encourage conservation. Nevertheless, these schemes are not without limitations. In fact little attention has been paid to the discussion of PES mechanisms, leaving the full attention to PES scheme proposals (Engel, et al., 2008). In this context little has been said about the contribution of environmental valuation procedures in PES schemes. If the "correct" value for payment is not a guess, the probability of ineffectiveness of the scheme increases. This lack of attention to this issue is particularly evident in developing countries, where PES schemes have been object of discussion for at least ten years.

Wunder (2007, p. 48) defines a PES scheme as "a voluntary, conditional agreement between at least one "seller" and one "buyer" over a well-defined environmental service – or a land use presumed to produce that service". However, even Wunder recognizes that a PES scheme with all these characteristics is difficult to find in real life situations. A successful PES scheme requires that the environmental service be well defined and monitored so that providers and demanders of the service can act in order to guarantee its continuity. Another desired characteristic is low transaction costs, which implies on a limited number of buyers and sellers. Well defined property rights are also helpful in securing the supply of the environmental service.

In a context like this, it is our working hypothesis that economic valuation should also play an important role when designing a PES schemes. Adequate valuation may be useful in defining a scheme, because it helps to determine the final price charged, which in ideal terms must reflect the minimum value that suppliers should accepted as a compensation for the service rendered and, at the same time, the maximum value demanders would be willing to pay for that service. However, estimating the monetary value of an environmental good or service can be a costly and difficult exercise (Engel, et al., 2008).

PES schemes should, in an ideal situation, only be implemented after an understanding of the environmental service supply characteristics as well as on the relationship between land use and environmental service supply. This scientific knowledge, together with accurate data collection to support PES design, plays an important role among the PES start up costs. Other costs are related to information gathering about the characteristics of suppliers and demanders participating in the PES schemes. Furthermore, constant data needs to be collected during the execution of the scheme to guarantee its success, through monitoring participant's activities and adherence to the scheme (Mayrand & Paquin, 2004).

Due to all these high costs, many PES programs are implemented based upon incomplete information which leads to negative consequences such as low payments and low adherence (Mayrand & Paquin, 2004). After all, payers want to be certain about the quality and amount of environmental service they are "buying". Even with a current and reliable data valuing an environmental service and estimating the relationships between land use and service provision is challenging and the many methods available present limitations and their applications relay on certain conditions.

In developing valuation procedures for PES schemes, we are searching for indirect use values of the total economic value (TEV, see Table 1). We need to estimate these indirect values today and in the futures (option value). The value of an environmental good or service can be estimated by observing consumer preferences for environmental conservation *vis-a-vis* its use. If we were interested in the direct use value, these goods are transacted in markets and, thus, they have a price. In this case, it is assumed that the market price for environmental goods and services correctly reflect economic scarcity and are, thus, economic-efficiency prices (Kengen, 1997).

Table 1: Examples of environmental goods and services considered when estimating TEV.

Total Economic Value				
Direct use value	Indirect use value	Option Value	Quase-Option Value	Existence value
• Wood Forest Products. • Non-wood Forest Products. • Educational, recreational and cultural uses.	• Protection of hydrographic basins. • Carbon sequestration. • Climate regulation. • Soil protection.	• Values derived from the benefit of direct or indirect uses in the future.	• The discovery of raw natural materials for the cure of cancer.	The value associated with the benefit derived from the existence of: • Biodiversity • Cultural and ethical values.

Table elaborated from Young & Fausto, 1997 and Kengen, 1997.

As stated PES schemes usually encompass environmental services used indirectly, such as watershed protection, carbon sequestration and biodiversity conservation. In this case, where these services are not traded in markets there are methods, techniques and procedures available to estimate their monetary values. These methods of economic valuation of environmental services are based upon neoclassical economic theory (Nogueira, et al., 2000). As it is well known, the most common methods are: a) Contingent Valuation Method (CVM); b) Travel Costs Method (TCM); c) Avoided Cost Method (MCE); d) Hedonic Price Method (MPH); e) Method Dose Response (MDR), and f) Replacement Cost Method (RCM). Table 2 shows in which case each method may be used. Note that sometimes, one method may be used to value different types of uses.

Table 2: The evaluation methods and the total economic value.

		Evaluation Methods (goods/services not traded in the market)					
		CVM	TCM	MPH	MCE	MDR	RCM
TEV	Direct Use Value	X	X	X		X	X
	Indirect Use Value	X	X	X	X	X	X
	Option Value	X		X			
	Quase-Option Value	X					
	Existance Value	X					

Table elaborated by the authors.

Economic Valuation in Latin America and Brazil

Occupying an area equivalent to 16 percent of the land area of the planet, Latin America has a large biodiversity: close to 50% of the planet's known reptile, bird and amphibians (Sedjo, 2007). Latin America is also home to many threatened species: 620 in South America and from those 115 in Brazil (IUCN, 2011). Brazil also has a wide range of values for environmental goods and services: the net present value for logging ranges between US$12/ha (Almeida & Uhl, 1995) to US$ 3,184/ha (Peters et al. 1989); non-wood forest products have even less value, US$1.22/ha (Schwartzman 1989); using the TCM the value of the coast of Rio Grande do Sul was found to be between R$37,92 and R$41,98/tourist/day (Finco & Adballah, 2002); watershed protection service of the water cycle in rural Amazonia is of US$ 130 billion/year (Fearnside, 1997). As can be observed from the information presented so far, results vary widely depending on the study, its aims methods and procedures.

As far as costs of PES are concerned, they seem to be easier to estimate than benefits. This may be the main reason for the result from this present study. Many PES schemes surveyed concentrated their efforts on calculating opportunity costs of the land use. For the same reason, Sedjo (2007) presents in his study more cost estimates (see Table 3) than in comparison to benefit measurements. However, costs of PES can only be justified in terms of their benefits. Measuring their values in monetary terms, therefore, is an important tool when designing PES schemes. There are various ways in which to value environmental services from carbon sequestration to its biodiversity.

Table 3: Estimates of the Costs of Protecting Latin American Biodiversity

Estimate (year)	Percent Protected	Cost
Sedjo (1992), Chathamhouse (2007)	10% of closed forest (67 million ha) area	US$1.23 billion/year (rental)
James (2001)*	10-15 % forest land	US$3.5-5.5 billion/year (rental)
Brumer (2001)*	2% terrestrial area	US$5.8 billion annually
Pearce (1996)	100% forest are Latin America	US$500 one time or US$25 billion/year discounted at 5%
Grieg-Gran (2006)	6.2 million ha/yr (1.5%) each year for indefinite period or an accumulation of about 1.5% of the global forest annually	US$5 billion purchase payment and US$25-US$100 million each year for administration
Kindermann et al., (unpublished)	Reduced rate of deforestation 10% to 50%	Cost is present value (PV) US$4.0-US$12.0 billion for the period through 2030; for a 10% reduction case PV of costs US$17.2-US$28.0 billion for the period through 2030 for the 50% reduction case
Simpson et al., (1996)	100%	Costs equal opportunity costs of the land at roughly US$150-200/ha

*Prorated from global estimates assuming Latin America has 20% of the area and costs.
Table reproduced from Sedjo (2007)

Many PES schemes lack not only in data but also in studies detailing the expected improvements derived from the environmental service (Kiersch, et al., 2005). Added to that, many compensation mechanisms are not based on a full economic valuation of the services. The amount charged for an environmental service should not be set without much thought. After all a lower price may, on the one hand, guarantee that demanders will pay for the use of ES. But it may, on the other hand, not be enough to gather suppliers willing to provide the service or, may gather only those willing to provide it until a better opportunity for their land use arrives (NOGUEIRA and HASENCLEVER, 2012).

Based on any procedure, a possible price for ES must range from a minimum that a supplier is willing to accept (WTA) to change his land use activities to a maximum a demander is willing to pay (WTP) to receive the service. This maximum amount must also be equal to the marginal benefit brought by the ES. These minimum and maximum amounts may be estimated by the use of valuation methods. A problem with implementing PES schemes surges when the minimum a landowner is willing to accept is higher than the demander's WTP. As we shall see later on, by concentrating only on the opportunity costs, some PES programs fail to identify the demander's WTP and consequently the possibility of a market for the environmental service in question.

Methods and Procedures

Our research procedures were conducted online consulting various websites and periodicals to collect information on PES schemes in Brazil and Latin America. Latin America is limited to those countries south of the United States with Romance languages as the official language. An attempt was made to encompass a variety of countries in Latin America as well as a number of different environmental services (ES) offered. It must be stated, though, that most PES schemes are concentrated on watershed protection services. In the end information on 21 (twenty one) projects were examined and data was collected on the use of environmental valuation to estimate the value of payments in PES schemes. Of these 21 projects, three are from Brazil, twelve from Central America and five from South America (Brazil not included, see Table 4).

Table 4: PES Programs surveyed by country

Country	Program
Belize	Rio Bravo Carbon Project
Bolivia	Los Negros PES scheme
Brazil	Green Grant
	Water Producer Program
	PCJ Consortium
Colombia	Program driven by the Wateruser Association (WUA)
	Chingaza National Park
Costa Rica	*Pago por Serviços Ambientales. Mecanismo financeiro: el Fondo Nacional de Financiamiento Forestal (FONAFIFO)*
	Certificates for Environmental Services
	Environmentally adjusted water tariffs
	Heredia
Ecuador	Pimampiro
	PROFAFOR
El Salvador	Lake Coatepeque
	El Impossible National Park
Guatemala	Cerro san Gil water source protection reserve
Honduras	Program for Sustainable Agriculture in Hillsides of Central America (PASOLAC)
Mexico	Payment for Hydrological Environmental Services Program
	Fundo Bioclimático Carbon Project
Nicaragua	San Pedro Del Norte
Peru	Alto-Mayo (Cuencas Andinas Project)

Table elaborated by the authors.

This is a first broad look at the role of environmental valuation in the design of PES schemes. Further in depth studies may need to be conducted to estimate the impact of the use of environmental valuation in PES schemes.

Results

Most of the PES schemes surveyed had payments on a per hectare basis and some varied according to the land use: conservation of natural forest, reforestation, agroforestry practices, among others (see Appendixes). This variation is explained by the fact that each type of activity generates a different amount of ES. For example, the value of a replanted forest is not the same as the value of a natural, untouched forest.

From the 21 cases studied 7 (seven) had conducted economic valuation at the time of the project design, of these 3 (three) estimated the opportunity costs of the land use, 2 (two) conducted contingent valuation procedures, 1 (one) conducted two different valuation procedures and 1 (one) plans on conducting avoided costs estimation (see Figure 1).

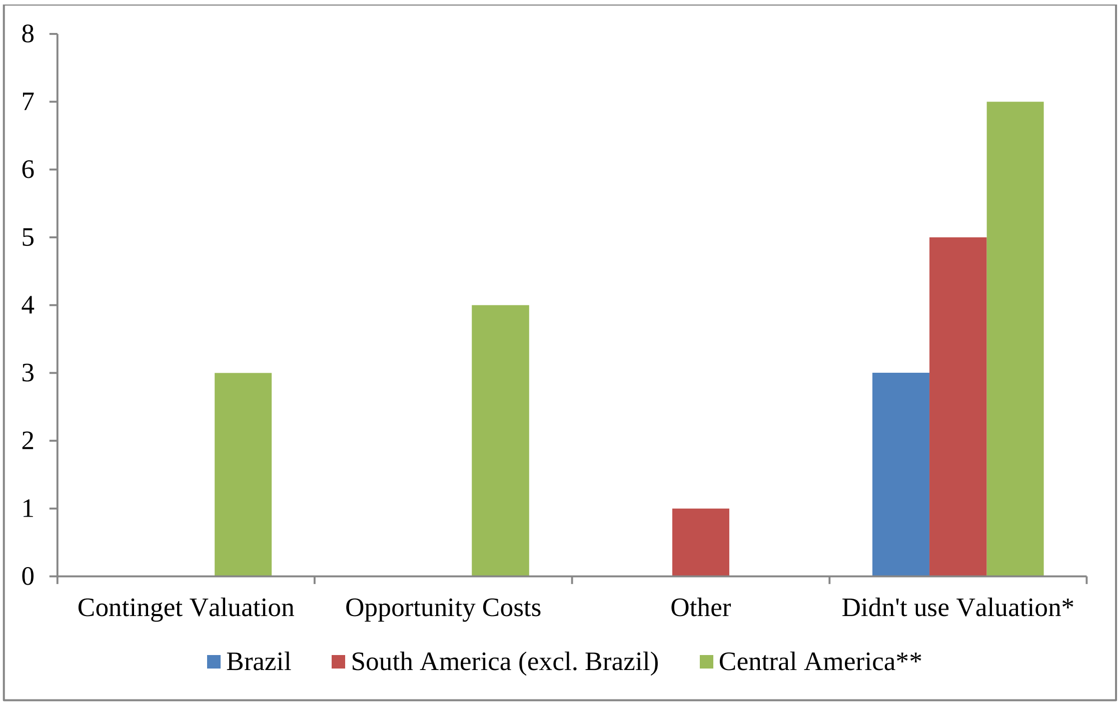

Figure 1: Cases that used economic valuation or not (n=21)
* Where information could not be found on the use of an economic valuation it was assumed that no valuation was conducted.
** A case study in Costa Rica conducted a WTP and a Opportunity Cost valuation.

These numbers indicate the little importance given to environmental valuation methods and procedures in the design of PES schemes. A reason for the small number of economic valuation practices may be linked to budget problems, given that economic valuation is a costly and time consuming exercise, but nonetheless required. When economic valuation was conducted there appeared to be a preference for contingent valuation and/or opportunity costs methods even though there is a wide range of other techniques available, as discussed previously. The choice for the estimation of opportunity costs may be related to Sedjo (2007) affirmation on the fact that costs are easier to estimate than the benefits.

In some of the cases surveyed economic valuations were conducted only after the program had started and were usually an initiative of scientists aiming at analyzing the efficiency of the program. This is the case of the watershed protection in the Colombian Andes. Moreno-Sanchez (2012) found that the willingness-to-pay of ES buyer was a US$1 higher than the price charge to households by the water-user association (WUA) and that is insufficient to cover all costs involved in the program.

A question that immediately rises is how, then, the value of the payment is estimated? In general the amount paid depends upon the funds available for the scheme, opportunity costs of the land use and the assumed importance of the environmental services supplied (Kiersch, et al., 2005). In some cases environmental valuation, such as contingent valuations, were conducted but the prices charged were set lower than the estimates obtained. In Jesus de Otoro, Honduras, the PES fee is equal to 3.6% of the estimated willingness-to-pay. The same is observed in Heredia, Costa Rica, where the price decided by politicians is lower then the WTP (Kosoy, et al., 2007). This difference between the value estimated and the actual value charged may be explained, therefore, by many factors: public budget availability, political reasons, difficulty in guaranteeing the service supply and discrepancies between the stated value and the actual ability to pay of households (Kiersch, et al., 2005; Kosoy, et al., 2007).

There is still another way of determining the PES fee: by dividing the PES programs' costs among demanders. This was a mechanism used by PROFAFOR in Ecuador, by the Rio Bravo Carbon Project, in Belize and by the Water Producer Program in Brazil. The problem with this approach is that higher yields could be made if the demanders were willing to pay more, which could mean more participants. Also, in some cases, such as that of carbon sequestration in Mexico, PES fees were set by the market. In other cases the opportunity cost of the land was estimated (ex. *Pago por servicios ambientales* in Costa Rica, *Lake Coatepeque* in El Salvador and Payment for Hydrological Environmental Services Program in Mexico). This type of estimation is usually made using land prices or the yield from other activities such as agricultural crops. In Brazil this type of calculation uses information available from the Brazilian Geography and Statistic Institute – IBGE, which supplies databases on agriculture, cattle and *flora* production (MMA - Ministério do Meio Ambiente, 2008).

From the seven PES programs that conducted an environmental valuation only three, FONAFIFO, *Lake Coatepeque* and Payment for Hydrological Environmental Services Program used the estimates when deciding the price charged for the ES (see Table 5). Two of these programs calculated the land use's opportunity cost to determine the amount received by ES suppliers and one, *Lake Coatepeque,* estimated the WTP to determine the amount charged to water-users. Only in the Costa Rica, *Heredia*, watershed conservation program was there a consirn about valuing both the demand and the supply side. However, even then, the PES fee was lower than the WTP estimated. The fee was set by political reasons instead of market reasons.

Table 5: The relationship between the use of economic valuation and the price charged

Scheme	Rio Bravo Carbon Project	Los Negros PES scheme	Green Grant	Water Producer Program	PCJ Consortium	Program driven by the Wateruser Association (WUA)	Chingaza National Park	*Pago por Serviços Ambientales. Mecanismo financeiro: el Fondo Nacional de Financiamiento Forestal (FONAFIFO)*	Certificates for Environmental Services	Environmentally adjusted water tariffs	Heredia	Pimampiro	PROFAFOR	Lake Coatepeque	El Impossible National Park	Cerro san Gil water source protection	Program for Sustainable Agriculture in Hillsides of Central America (PASOLAC)	Payment for Hydrological Environmen Services Program	Fundo Bioclimático Carbon Project	San Pedro Del Norte	Alto-Mayo (Cuencas Andinas Project)
Was Valuation Conducted	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	Y	N	N	Y
Does the value reflect the price charged?								Y		N	N			Y			N	Y			

Y: Yes; N: No

*In the Case of the Peruvian PES scheme the price and the valuation study have not been conducted.

Methods of payment and the amount vary between the schemes. In the Bolivian Los Negros PES scheme, for example, payment is made in forms other than cash. Participants/Suppliers earn beehives in order promote production activities that go along with the conservation of the environment (Asquith, et al., 2008). In the Brazilian Water Producer Program suppliers are paid monetary amounts depending on the type of activity they conduct be it reforestation or conservation of natural forests. A variation of payments depending on the activities conducted is also practiced by the *Pagos por Servicios Ambientales* in Costa Rica.

Wunder (2007) points out that there are common problems concerning PES schemes in Latin America: payments are made by donors and not by service users, service users were charged but the money was not used to pay potential suppliers, an unclear connection between the ES service and the land use, poor program monitoring or lack of, upfront and non-continuous payments, payments were made without an assurance of the actual service supplied. There seems to be reluctance in facing a PES scheme as a business. Instead, governments, such as the Brazilian, prefer to view it as a poverty reduction and yield redistribution program. From the 287 programs reviewed by Landell-Mills and Porras (2002) only a hand full fits a business like profile of the type: you pay for what you get (Wunder, 2007).

Discussion

Even though an environment can offer a wide variety of services, their price ultimately depends on the price demanders are willing to pay and the price suppliers are willing to accept. At times, not even a study on the market in terms of possible suppliers and buyers is conducted prior to the establishment of the PES. Thus a first step in designing PES schemes is the analyses of possible demanders of the environmental services being generated. What was usually noticed in many of the cases of PES studied is that economic valuation of the environmental service is a secondary step. Many valuation studies are conducted after the implementation of the program. An evaluation conducted previously is beneficial and avoids problems, as the one in the Brazilian Forest Grant Programs (ex. Green Grant Program), where government funding is necessary to maintain the program's continuation.

From the PES schemes investigated only a few, namely 3, displayed the use of economic valuation in determining the price to be paid or the amount to be received by the buyer or supplier respectively. Those programs that used economic valuation worried about valuing only one of the sides, supplier or demander, by estimating opportunity costs or the willingness-to-pay. Even when both estimations were conducted, as in the case of Heredia, the PES fee was set by other parameters than with the aid of the calculations previously made.

Economic valuation on both sides of the market, suppliers and demander, is of importance to determine if the PES scheme has a market and, as a consequence it will really function. For this to be true, the opportunity costs must be lower than the willingness-to-pay. Government spending on financing PES schemes, as is happening in the Brazilian PES program – Green Grant - has its downside. It implies a trade-off between environmental and social actions and goes against the actual intention of the creating a PES scheme, which is creating a market for environmental services. The idea is that this market is able to function without government intervention, a part from regulatory actions.

Conclusion

The aims of this paper were to investigate how economic valuation has been used in PES schemes in developing countries and to verify if economic valuation can be an useful tool to increase the effectiveness and efficiency of these schemes. As a general result we can say that yes, valuation is a useful tool as far as PES are concerned. However, it has not been much used in those countries.

It cannot be assumed that people are willing to change their behavior for any payment or that everyone will be glad to contribute to the environmental through raises in their bills. This is when economic valuation comes in place. From the sample analyzed it seems that there is an assumption that demanders of environmental services are prepared to pay at least the opportunity cost of the land to the suppliers, when demanders' WTP could be in fact higher or even lower than the land's opportunity cost.

Another fact observed is the preference for WTP and opportunity costs valuation, even though there is a great range of valuation techniques available. One wonders if valuation methods such as the dose-response, the hedonic price method and the avoided costs could not have been considered. The preference for the opportunity costs estimation may be due to its lower costs, since estimations can be done using an average of statistical data already available.

For PES schemes to function the properties of a market must be established, information on the product being marketed must be available. Land properties must be clearly defined. Administrative measures, such as monitoring, must be taken. Without these measures PES programs become other public policies such as yield redistribution and equality programs, failing its initial purpose: trading environmental services.

A next step in this area is a study looking into developed and developing countries PES schemes to see if there is a pattern in the use of environmental valuation in the design of PES schemes. It would be interesting to see if the pattern observed in this study remains when considering PES schemes in developed countries. Through valuation, one becomes not only aware of the importance of environmental services to society, but also of the social costs arising from their destruction. Valuation is an important tool in designing PES schemes, by not only transforming into prices the value of environmental services but also by highlighting supplier and demanders willingness-to-pay and willingness-to-accept. In this sense environmental valuation should be a compulsory element in PES design for it is essential in the creation of programs to pay for environmental services.

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Appendix

Table A.1: Cases studied by program, service offered, supplier, buyer, payment method, amount, operation agent, whether or not valuation was used and source

Country	Program	Service Offered	Supplier	Buyer	Payment Method	Amount received by Supplier	Operated by	Used Economic Valuation	Source
Belize	Rio Bravo Carbon Project	Sequestration of 10 million tCO2eq from 1995-2035	Belizian NGO - Programme for Belize	Consortium of US and Canadian energy utilities		Undiscounted price of US$0.25/tCO2eq	Belizian NGO - Programme for Belize and The Nature Conservancy and a consulting firm - Winrock	No. Price based on the expected costs of the project	Cobera et al., 2007
Bolivia - Los Negros	Los Negros PES scheme	Watershed and fauna conservation	Landowners	US Fish and Wildlife Service (Biodiversity service); Pampagrande Municipality (Water Service)		beehives, apicultural training, and barbed wire.		No economic analyses was conducted. Vargas (2004) did a WTP study later on.	Asquith et al., 2008
Brazil	Green Grant	Forest Conservation. Null deforestation of native forests.	residents of Conservation Units and residents of agrarian reform settlements	Union Treasury	Payments for two years renewed for another two years	US$636,53/family/ year	Federal Government	No.	Viana, 2011
Brazil	Water Producer Program	Soil Conservation, reforestation, forest conservation	Choosen Registered Landowners	Nacional Water Agência (ANA)	Funds were gathered through a partnership between private and public companies.	*Soil conservation: US$16 - US$42,50 Reforestation or conservation: US$26,50 - US$106 Conservation of Native Vegetation: US$21 - US$85	Nacional Water Agência (ANA)	No. Payments are based on the extra costs involved in implementing each activity.	Chaves et al., 2004
Brazil	PCJ Consortium	Water flow regulation	Private Landowners	Local Government, Municipal Water Utility of Piracicaba - SEMAE	SEMAE pays US$0.0045/m³ of distibuted/consumed drinking water	US$0.0045/m³ of distributed water, seedling and reforestation plans	PCJ Consortium - Inter-municipal Basin consortium of the Piracicaba, Capivari and Jundiaí rivers	No. Decision made among members of the PCJ.	IIED, 2007
Colombia	Program driven by the Wateruser Association (WUA)	Changes of land-use practices, reforestation,	Upland farmers	880 households: Smallhold farmers and recreational-house owners	Users pay US$0.5/household/ month	Average of R$136/ha	Wateruser Association (WUA)	No. Moreno-Sanchez et al., 2012 did a WTP valuation afterwards	Moreno-Sanchez et al., 2012
Colombia	Chingaza National Park	Carbon sequestration	Chingaza National Park and Central Hydroelectric of Santa Ana		Payment is made by buying emission reductions certificates (CER)	US$3,500 from the sales of CER	Empresa de Alcantarillado y Acueducto de Bogotá (EAAB)	Not mentioned	Programa FAO/OAPN, 2009
Costa Rica	*Pago por Serviços Ambientales. Mecanismo financeiro: el Fondo Nacional de Financiamiento Forestal (FONAFIFO)*	Specific land uses (reflorestation, forest protection, sustainable lodging, agroforestry services)	Landowners		3,5% of revenues from fuel consumption taxes, yield from Environmental Services Certificates selling, and voluntary agreements with hydroeletrical cias.		National Fund for Forest Financing FINAFIFO	land's oportunity cost	Wunder, 2007
Costa Rica	Certificates for Environmental Services	Proctection and regeneration of 7000ha of forests in Guanacaste	Landowner	Sponsors - mainly private companies	Certificates of one hectare are sold to sponsors, these cost $60/ha/yr for minimum of 5 years (=$300 per ha)	Forest protection: US$320/ha. Natural regeneration with production potencial: US$816/ha Natural regeneration in potreros: US$205/ha Reflorestation: US$816/ha Agroforestry systems: US$1.30/tree	FONAFIFO	No	Porras et al., 2006
Costa Rica	Environmentally adjusted water tariffs	Watershed conservation	Landowners	Hydroelectrical Power Companies	Water charges are a fraction of the water consumer's WTP.	US$12/ha/yr - US$45/ha/yr	agreement between La Manguera AS and Monteverde Conservation League (NGO)	Land's oportunity cost and Contingent valuation.	Pagiola, 2008; Programa FAO/OAPN, 2007; Porras et al., 2006

* Prices were converted from Real to US Dollars following the exchange rate from 04/27/2012 of US$1,00 = R$1,8852

Table A.1: Cases studied by program, service offered, supplier, buyer, payment method, amount, operation agent, whether or not valuation was used and source (continuation)

Country	Program	Service Offered	Supplier	Buyer	Payment Method	Amount received by Supplier	Operated by	Used Economic Valuation	Source
Costa Rica	Heredia	Control and prevention of fires, forest conservation, reforestation	29 Landholders	Households and a beverage company	Users pay in average 6% of their water fee to PES scheme (US$ $0.008/m^3$)	An average of US$45.40 ha/year	ESPH S.A. (Public Local Enterprise for water provision and sanitation)	WTP	Kosoy et al., 2007
Ecuador	Pimampiro	Watershed protection	households residing in lower-altitude farmlands or in nearby towns	Waterusers and Local Government	Contributions from water utilities. Payments from the electric power company. Transaction costs covered by the government	U$21/month per household	Water fund (FONAG)	No	Wunder, 2007 and IIED, 2007
Ecuador	PROFAFOR	Carbon-sequestration	individual and communal landholders	Dutch electricity companies		Initial payments 80% of total, (=US$100-US$150/ha) for seedlings production and plantation, the other 20% is paid after three years (=US$25-US$37,50/ha) and in-kind benefits from by products. Min 70% of revenues from sales of harvested trees after 15-20 yrs and 100% if they reforest.	PROFAFOR	No. Payments cover seedlings and labor costs of the participants	Wunder and Alban, 2008.
El Salvador	Lake Coatepeque	Water quality	Public, private and cooperative landowners	Recreational users, Domestic water users, Small scale fishing	Intermediary-based transactions, through FONASA and local NGOs	Annual payments. First 5 years US$ 200/ha/year then US$25/ha/year	National Environmental Services Fund (FONASA) and local NGO Foundation (FUNDACOATEPEQUE)	Opportunity Costs	IIED, 2007
El Salvador	El Impossible National Park	Watershed Protection and Scienic Beauty	El Impossible National Park	Waterusers from the San Francisco Menéndez Municipality	Water Tariff and Park Entrance	US$6,05/family/month and entrance tickets to the park US$2,90	Intermediary: Local Government	No	IIED, 2007 and Programa FAO/OAPN, 2009
Guatemala	Cerro san Gil water source protection reserve	Protection of area in the headwaters of the River Las Escobas	Fundación para el Ecodesarrollo y la Conservación (FUNDAECO)	Empresa Hidroeléctrica del Atlántico (HEDASA)	Increase of US$0,20/month in the water tariff	US$17,86/ha/year	FUNDAECO	No	IIED, 2007 and Corbera et al., 2007
Honduras	Program for Sustainable Agriculture in Hillsides of Central America (PASOLAC)	Better environmental practices and forest conservation	Upstream landowners	Waterusers, organized by the local Council for Adm. of Water and Supply Disposal.	Fee of US$0.06/household/month in the water bill	Varies according to the practice adopted. In average of US$12.4/ha/year.	Local Council for Administration of Water and Supply Disposal	WTP	Kosoy et al., 2007
Mexico	Payment for Hydrological Environmental Services Program	Conservation of forests in hydrologically critical watersheds	Landowners	Government and Water users	Water charges (max. fee of 4% of the budget)	US$18.2/ha/year - US$27.3/ha/year	Federal Government	Average opportunity cost of the land	Wunder, 2007; MUÑOZ-PIÑA et al. 2008
Mexico	Fundo Bioclimático Carbon Project	Carbon sequestration		The Carbon Neutral Company, Tetra Pak, International Automobile Federation and The World Bank	Sold 60,498 tonnes of carbon dioxide equivalent (tCO2eq)[2] over 30 years (1997-2000) for US$3.27/tCO2eq and between 2000-2005 36,666 tCO2eq was sold	US$2.18/tCO2eq is allocated directly to farmers the rest is used to cover other administration costs	Fundo Bioclimático Carbon Project	No.	Cobera et al., 2007 and Brown and Cobera, 2003
Nicaragua	San Pedro Del Norte	Conservation and management of forests	Landowners	125 households	US$0.31/month	US$26/ha/year	The Water Committee	Not mentioned	Kosoy et al., 2007
Peru	Alto-Mayo (Cuencas Andinas Project)	Watershed protection and reduction fo deforestation	Private Landowne	Government, Moyobamba city water utility company and local users association	Contributions of US$3.6/year/user	Cash Payments (conditions and frequency undetermined)	Intermediary: CONDESAN	An estimation of the avoided costs to the water utility company is to be conducted	

* Prices were converted from Real to US Dollars following the exchange rate from 04/27/2012 of US$1,00 = R$1,8852