# Effective Implementation of Payments for Environmental Services in Lao PDR

# PAYMENTS FOR ENVIRONMENTAL SERVICES: CONCEPTS AND APPLICATIONS

Gabriela Scheufele[1] and Jeff Bennett[2]

[1,2]Crawford School of Public Policy, Australian National University

**Executive summary**

A payments for environmental services (PES) scheme is a mechanism that aims to link existing environmental services (ES) demand and potential ES supply. This link is established through the interventions of one or multiple agents who intercede between prospective ES buyers and sellers to facilitate trade of otherwise non-marketed, 'unowned' ES. Agents act as 'brokers' with the capability of reducing the costs of engaging in exchange otherwise known as transaction costs.

Possible reasons why PES exchanges are not profitable for the suppliers and buyers include:

- property rights over the ES are not well defined, defended, and/or divestible;
- lack of trust between buyers and sellers;
- high costs of negotiations between many buyers and many sellers;
- limited knowledge of the cause-effect relationships between inputs (actions) and outputs (ES); and
- costly or non-viable payment transfer options.

The basic steps in developing a PES scheme include:

- selecting the geographic area to be involved;
- cataloguing the ES to be supplied;
- identifying the sources of existing ES demand and potential ES supply;
- defining the type and degree of agent intervention;
- selecting the ES buyers/ securing funds to pay for the ES supply;
- identifying the types of returns to ES suppliers;
- developing the payment system;
- selecting the ES suppliers;
- developing the payment transfer mechanism;
- developing a monitoring system to assess supplier performance;
- developing a penalty system to punish non-compliance;
- contracting the ES suppliers (and ES buyers);
- paying the ES suppliers and enforcing penalties for non-compliance; and
- assessing the scheme's performance.

Numerous PES schemes have been developed around the world in the last few decades. Since they have been customized to local conditions they all differ to some degree. PES scheme designs can be differentiated by a mix of characteristics, which significantly impact on their economic efficiency, their effectiveness in delivering ES, and the distribution of net returns between buyers and sellers. These characteristics include:

- *Transparency of the scheme*
Tacconi (2012) follows Kolstad and Wiig (2008) to define transparency as "… the timely and reliable provision of information to all relevant stakeholders" (Tacconi 2012, p.33). Non-transparent PES schemes may be restricted in their potential to increase the supply of 'unowned' ES. The terms and conditions of a PES scheme as well as associated risks of participation need to be clear to all involved (buyers, sellers, agents). Non-transparent schemes may suffer from a lack of trust (Muradian et al. 2010), restricted competition

(Midgley et al. 2012), and corruption (Ferraro 2008), which may limit PES schemes in their potential to increase the supply of 'unowned' ES.

- *Additionality of ES supply*

Additional provision means that the ES provision of any seller within a PES scheme is additional to that which would have been provided in the scheme's absence (Wunder 2007, Tacconi 2012). Non-additional ES supply does not increase social well-being but mainly redistributes wealth.

- *Conditionality of payments*

Payments are conditional in the sense that they are only made upon delivery of contracted ES or management actions (Wunder 2005, Tacconi 2012). Non-conditional payments are expected to result in a small or negative net marginal benefit being gained through a PES scheme. Ensuring conditionality requires the establishment of a monitoring and penalty system to detect and punish non-compliance.

- *Voluntariness of seller participation*

If participation is compulsory, sellers may have to engage in a PES scheme even though they will be made worse-off (Tacconi 2012). As a result, forced participants who experience a net loss have a strong incentive to 'do a bad job' and the PES scheme would not be expected to be effective in supplying ES. Society may be made worse-off.

- *Type and degree of agent intervention*

Agents may be government departments, non-governmental organisations, research institutions, multilateral donors or private entities. The degree of intervention required to facilitate a PES exchange depends on the magnitude of the transaction costs faced by buyers and sellers. Some cases may require only limited intervention to make an exchange worthwhile for buyers and sellers, while others may demand strong intervention to make trading mutually beneficial. It is important to acknowledge that intervention is only warranted if the transaction costs borne by sellers, buyers, and agents are less than the net returns to buyers and sellers in the PES exchange. Otherwise, society is made worse-off.

- *Type of returns received by sellers*

Returns received by sellers can be direct returns (monetary or in-kind payments) and/ or indirect returns (any returns that are additional to the direct returns) (e.g., Midgley et al. 2012). The net returns to sellers (producer surplus) are the difference between the total returns (direct and any indirect returns) sellers receive from their participation in the scheme and their individual marginal costs of ES supply. The net returns to buyers (consumer surplus) consist of the marginal benefits generated from the consumption of ES supply less the required payment to ES sellers. Economically efficient payment systems require taking any indirect returns received by sellers into account.

- *Seller type*

Potential sellers are defined as those who have legal control over the provision of ES. They can be individuals, communities, or government departments (e.g., Engel et al. 2008). If communities act as sellers the PES scheme has to specify how effort (marginal costs of supply) and total returns are to be distributed among community members. Challenges may include perceived fairness (Fehr et al. 2002, Sommerville et al. 2010) and 'elite capture' (Kellert et al. 2000).

▪ *Seller selection mechanism*

A PES scheme that selects sellers based on a ranking of proposals using benefit-cost analysis (BCA) principles (e.g., Hanley et al. 1993) enables the selection of the highest net benefit providers and allows the exclusion of proposals that would result in a net loss to society (PES in Sichuan Province, China). The application of BCA principles requires information on generated marginal benefits and marginal costs of supply that can be obtained through bio-economic models, economic valuation and reverse auctions. The application of BCA principles ensures that PES schemes are economically efficient in that they make society better-off. Other selection mechanisms (beyond the basic eligibility criteria) such as the environmental-benefit-index/ cost (EBI/C) ranking (Ecotender in Victoria, Australia) or the 'first-come-best-dressed' principle do not allow for that depth of assessment. PES schemes that apply these selection mechanisms bear the risk of making society worse-off.

▪ *Payment system*

Payment systems are defined by the process used to determine the payment system negotiated between the sellers and the buyers (PES in north-eastern France) or stipulated by law (PES in Vietnam), a payment schedule, a payment base (input used or output generated), a payment definition (unit payment or total payment), and a payment rate. The choice of the payment system largely determines how the net returns (ignoring any indirect returns) are distributed between individual sellers.

Payment systems that apply payment rates based on individual marginal costs of supply (e.g., Ecotender in Victoria, Australia; PES in Sichuan Province, China) result in equal distributions of net returns for the same quantity of inputs or outputs to sellers even though the payment rates differ across individual sellers (ignoring any informational rents and indirect returns). By contrast, payment systems that apply uniform payment rates (e.g., PES in Los Negros, Bolivia; PES in Costa Rica) or payment rates based on marginal benefits enjoyed by the buyers (PES in Lam Dong Province, Vietnam) lead to unequal distributions of net returns for the same quantities of inputs or outputs across sellers.

The choice of the payment system also affects how the net returns (ignoring any indirect returns) are distributed between sellers and buyers (or their agents). Payment systems that apply payment rates based on marginal benefits enjoyed by buyers (e.g., PES in Lam Dong Province, Vietnam) distribute the net returns in favour of the sellers. Payment systems that apply payment rates based on marginal costs of supply (Ecotender in Victoria, Australia; PES in Sichuan Province, China) distribute the net returns in favour of the buyers (or their agents). Reduced public spending in achieving ES supply goals increases the overall resources available to supply ES or other targets of government expenditure (e.g., education, health) elsewhere. However, cost-effective PES schemes deny sellers the opportunity to secure any net returns (ignoring any indirect returns) as happens in traditional competitive markets.

An alternative is a payment system that applies payment rates equal to the marginal costs of the highest cost (but still socially efficient) supplier. This payment system allows sellers to extract the type of net returns that are enjoyed by sellers in competitive markets. The net returns are shared between sellers and buyers (or their agents). The magnitude of

the net returns received by sellers and buyers (or their agents), respectively, depends on the price elasticity of demand and supply.

- *Seller performance measure*

The performance of ES sellers can be assessed using input-based or output-based performance measures (Latacz-Lohmann et al. 2005, e.g., Engel et al. 2008, Hanley et al. 2012). Some PES schemes do not assess seller performance. Not assessing seller performance makes it impossible to make payments conditional on the delivery of ES. The impossibility of conditioning payments on ES delivery is likely to result in a small or no increase in ES supply. Society may be made worse-off by such schemes.

## 1. Introduction

Environmental Services (ES) have been defined as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life" (Daily 1997) [1]. ES can be divided into provisioning services (e.g., food, fresh water), regulating services (e.g., flood regulation, water purification), cultural services (e.g., recreational services, aesthetic services), and supporting services (e.g., soil formation, primary production) (Hassan et al. 2005). An ecosystem can be managed to supply a variety of ES. Some types of services can be co-supplied (fresh water/ biodiversity). Others are rival (timber/ biodiversity). For example, felling a forest for timber production (provisioning service) may degrade or destroy the water filtration capacity of the once forested area (regulating service).

Many provisioning services are private goods. Private goods are excludable. Anyone who does not pay for private good ES can be excluded from using them since ownership (property rights) over these ES is well defined and defended. As a result, voluntary transactions between buyers and sellers of private good ES generate net benefits that are high enough to offset the costs associated with engaging in the exchange. In this way, markets emerge for private good ES.

Particularly in recent years, there has been increasing demand for ES that do not have well defined and defended property rights such as regulating, cultural, supporting and some provisioning services (e.g. water supply in some regions). Profit orientated suppliers have no or limited incentives to supply these ES. The costs of defining and defending the property rights are too high to make trade for the suppliers profitable. This is because the ES in question often have public or common good characteristics. Both types of ES are 'open-access' resources. Sellers do not have the legal right or ability to exclude anyone who does not pay for the provided ES. Even if an ES beneficiary has not paid, they cannot be prevented from accessing the benefits. 'Free-riding' – benefiting from the ES without paying – predominates. The sellers bear all the costs of providing the

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[1] Daily's definition refers to 'ecosystem services'. This report treats the terms 'ecosystem services' and 'environmental services' as synonyms.

ES but they do not get any or only small revenue from offering the ES for sale. This situation arises because ownership (property rights) over these resources are not well defined and/ or well defended[2]. With ownership in doubt, there are no or limited incentives for ES to be supplied. Hence, the costs of linking supply with demand through market exchange are too high for transactions to occur. Yet, not everyone is a free-rider. Some 'unowned' ES are supplied by private sector entities. However, the demand for 'unowned' ES by private sector entities is often globally dispersed making direct negotiations between individual buyers and sellers costly. Again, the costs of engaging in exchange are too high for markets to emerge.

Since demand for many of these 'unowned' ES is larger than privately motivated supply an increase in their provision has the potential to increase social well-being. As a response, governments have sought to develop policies that involve public sector intervention to expand ES supply. This has initiated the development of Payments for Environmental Services (PES) schemes designed to stimulate ES supply through the payment of financial incentives to prospective suppliers[3].

PES schemes have become popular in managing natural resources around the world. A PES scheme is a mechanism that seeks to link existing ES demand and potential ES supply. This link is established through one or multiple agents interceding between prospective ES buyers and sellers to facilitate trade. Agents may be government departments, non-governmental organisations, research institutions, multilateral donors or private entities. Agents act as 'brokers' with the capability of reducing the costs of engaging in exchange otherwise known as transaction costs. Transaction costs are defined as " … the expenses that buyers and sellers face in organising and carrying out the process of exchanging resources" (Midgley et al. 2012, p.32). The reduction of transaction costs makes trading with otherwise non-marketed, 'unowned' ES mutually beneficial to buyers and sellers. Transaction costs can be lowered through PES agents

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[2] For a more detailed discussion about property rights, public goods, common goods, and free-riding see, for example, Tietenberg and Lewis (2009).

[3] For a discussion about whether a PES scheme can be a win-win mechanism for both environmental protection and poverty alleviation or whether other mechanism focused on poverty alleviation including direct payments to the poor are better suited for that purpose, see, for instance, Muradian et al. (2010), Engel et al. (2008), and Hanlon et al. (2010).

external to the trade who can define and/ or defend the property (ES) that is to be 'sold'. If free-riding prevails the government can act as the representative of the broader community and be the buyer of ES. In taking this step, governments, through their power to raise funds through general taxation, force their citizens to be 'buyers' of ES when they act as a PES agent.

It has to be stressed that the development and implementation of a PES scheme is only warranted if the transaction costs borne by the buyers, sellers, and agents are less than the net returns to buyers and sellers in the PES exchange.

The basic steps in developing a PES scheme include:

- selecting the geographic area to be involved;
- cataloguing the ES to be supplied;
- identifying the sources of existing ES demand and potential ES supply;
- defining the type and degree of agent intervention;
- selecting the ES buyers/ securing funds to pay for the ES supply;
- identifying the types of returns to ES suppliers;
- developing the payment system;
- selecting the ES suppliers[4];
- developing the payment transfer mechanism;
- developing a monitoring system to assess supplier performance;
- developing a penalty system to punish non-compliance;
- contracting the ES suppliers (and ES buyers);
- paying the ES suppliers and enforcing penalties for non-compliance; and
- assessing the scheme's performance.

Numerous PES schemes have been developed around the world in the last few decades. Since they have been customized to local conditions they all differ to some degree. Tacconi (2012) assembles four PES scheme characteristics that are desirable[5].

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[4] Seller selection mechanisms that are based on benefit-cost analysis principles require (1) predicting the ES that result from the supplied inputs (bio-physical models), and (2) estimating the value to society of the ES supplied (economic valuation).

[5] Tacconi (2012, p.35) defines a PES scheme as " … a transparent system of additional provision of environmental services through conditional payments to voluntary suppliers".

Characteristics are desirable if they improve the effectiveness (increase in supply of a desired ES quantity/ quality) and economic efficiency (improvement of social well-being through an increase in the supply of ES quantity/ quality) of a PES scheme. The desirable characteristics of a PES scheme assembled by Tacconi (2012) are:

- transparency of the PES scheme;
- additionality of ES supply;
- conditionality of payments; and
- voluntariness of sellers.

Past and current PES schemes differ in the degree to which they embody these characteristics. PES schemes are also differentiated by other characteristics such as the type and degree of agent involvement, the type of returns received by sellers, seller type, seller selection mechanism, payment system and performance measure. The combination of all these characteristics impacts on a PES scheme's effectiveness, economic efficiency and effect the distribution of net returns between buyers and sellers.

The aim of this report is to provide a consolidation of the literature to date and to establish a foundation for the development of future PES schemes through a set of policy guidelines. It is organised as follows. A discussion of the four desirable characteristics of PES schemes (transparency, additionally, conditionality, and voluntariness) and their importance in increasing social well-being is presented first. Subsequently, other characteristics that differentiate PES schemes are outlined and their impacts on effectiveness, economic efficiency and net return distribution are discussed.

In the final section, a sample of PES schemes is used to illustrate the importance of the four desirable characteristics and to demonstrate differences across PES scheme designs. A sampling approach in the analysis of applications is taken because it is beyond the scope of this report to provide an exhaustive overview of past and current PES schemes. Such an overview can be found elsewhere[6].

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[6] For example, the special section/ volume in Ecological Economics on payments for ecosystem services (volume 69, issue 6 & 11, 2010; volume 64, issue 4, 2008), Ferraro (2009), Huang *et al.* (2009), Southgate and Wunder (2009), and Wunder *et al.* (2008).

## 2.    Desirable PES scheme characteristics

### 2.1   Transparency

Tacconi (2012) follows Kolstad and Wiig (2008) to define transparency as "… the timely and reliable provision of information to all relevant stakeholders" (Tacconi 2012, p.33). The terms and conditions of a PES scheme as well as associated risks of participation need to be made clear to all involved (buyers, sellers, agents) in order to gain the trust of potential participants (Muradian et al. 2010), to support unrestricted supply competition (Midgley et al. 2012) and reduce (the perception of) corruption (Ferraro 2008). Lack of trust, restricted competition, and (the perception of) corruption all raise transaction costs, and thus limit a PES scheme in its potential to increase the supply of 'unowned' ES. Transparency of a PES scheme can be facilitated, for instance, by providing information on the site selection process, the seller selection mechanism, the ES valuation rules, and the process used to determine the payments to ES suppliers (Tacconi 2012).

### 2.2   Additionality

Additional provision means that the ES provision of any seller within a PES scheme is additional to that which would have been provided in the scheme's absence (Wunder 2007, Tacconi 2012). Additionality is crucial to ensuring that additional net benefit is created through the PES scheme. If ES supply is not additional a PES scheme would make society as a whole worse off because the additional costs of the scheme would be born without any associated additional benefits. Society would forgo the opportunity to allocate scarce resources (e.g., public funds) to stimulate the generation of additional benefits elsewhere. Ensuring that a PES scheme provides additional ES requires the definition of a baseline and the determination of the PES scheme's scale and scope. This involves setting geographical and temporal boundaries and defining seller and buyer eligibility.

## 2.3   Conditionality

Payments are conditional in the sense that they are only made upon delivery of contracted ES or management actions (Wunder 2005, Tacconi 2012). If payments are not conditional it could be expected that sellers would not fulfil their commitments to supply. Hence it is unlikely that the PES scheme would deliver a net benefit to society. Put simply: "If lack of conditionality results in the outright failure of the scheme to deliver the ES, then all resources allocated to the scheme would have been wasted …" (Tacconi 2012, p.33). Conditional payments require enforceable contracts[7] that define the rights and responsibilities of ES sellers and ES buyers. In particular, the 'product' (ES) buyers purchase needs to be defined and quantified. If payments are based on input performance, the cause-effect relationships between management actions and ES provision need to be established to ensure that the contracted inputs generate the desired outputs. A monitoring and a penalty system need to be established to detect and punish non-compliance (Midgley et al. 2012). The benefits may not be observed for many years after the start of the PES scheme. Limited up-front payments followed by a sequence of follow-up payments when milestones are achieved can reduce the risk of non-compliance across time (2008). Latacz-Lohmann (2005) suggests that the main drivers of non-compliance are (1) the probability of detection, (2) the expected severity of the penalties, (3) the rigor of the definition of the contracted activities, and (4) the payment rate. A high probability of detection, enforced and costly penalties, rigorous definitions of contracted activities and a payment rate attractive to sellers have the potential to reduce non-compliance.

## 2.4   Voluntariness

The fourth desirable PES scheme characteristic is seller voluntariness. If the participation of sellers is not voluntary, sellers may or may not be made better off through their participation in the PES scheme (Tacconi 2012). Sellers would only voluntarily engage in a PES scheme if they are made better off, that is, if their returns on participation outweigh

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[7] For a contract to be enforceable it needs legal standing (e.g., in contract law).

their marginal costs of ES supply. Marginal costs of ES supply include the opportunity costs of forgone benefits from alternative land use (e.g., planting trees instead of harvesting crops), costs to fulfil the contract (e.g., purchase of seedlings, labour), and a risk premium (Bennett et al. 2011). Volunteers have an incentive to 'do it well'. If, on the other hand, participation is compulsory, sellers may have to participate in a PES scheme even though they will be made worse-off. That is, their marginal costs outweigh the returns they receive from participation. As a result, forced participants who experience a net loss have a strong incentive to 'do a bad job' and the PES scheme would not be expected to be effective in supplying ES. Society may be made worse-off.

It has to be noted that the PES scheme definition of Tacconi (2012) differs from the widely used PES definition of Wunder: "A PES is a voluntary transaction where a well-defined ES (or a land-use likely to secure that service) is being 'bought' by a (minimum one) ES buyer from a (minimum one) ES provider if and only if the ES provider secures ES provision (conditionality)" (2005, p.5). This definition indirectly implies that both sellers and buyers need to be volunteers. Yet, the requirement for buyers to be volunteers limits the applicability of a PES scheme because it leaves schemes open to the problem associated with 'free-riding' when the ES is 'unowned'. In these circumstances, the government can act as the representative of the broader community and be the buyer of ES in PES 'markets'. In taking this step, governments, through their power to raise funds through general taxation, force their citizens to be 'buyers' of ES when they act as a PES agent.

### 3. Other differentiating characteristics of PES schemes

The numerous PES schemes that have been developed around the world in the last few decades all differ to a certain degree since they have been customized to local conditions. Local laws and regulations, natural resource endowment, goals, socio-economic factors, policies, and politics have influenced the design of PES schemes. This implies that those designing new PES schemes have a range of choices to make regarding the style of their scheme. This section illustrates such choices and discusses their impacts on a PES scheme's effectiveness, economic efficiency and distribution of net returns between buyers and sellers.

### 3.1 Type and degree of agent intervention

The degree of intervention required to facilitate a PES exchange depends on the magnitude of the transaction costs faced by buyers and sellers. In some cases, strong intervention may be required to make an exchange worthwhile for buyers and sellers. Other cases may require only limited intervention to make trading mutually beneficial. As stressed previously, it is important to acknowledge that intervention is only warranted if the transaction costs borne by sellers, buyers, and agents are less than the net returns to buyers and sellers in the PES exchange. Otherwise, society is made worse-off.

The transaction costs of engaging sellers and buyers may be lowered to the point that exchange is mutually advantageous if an agent provides scientific knowledge so that the 'product' (ES being sold and bought) can be adequately defined. For instance, a research institution may support the establishment of hydro-geological models for a PES scheme involving water provision improvements. The models may establish trust between buyers and sellers regarding the cause-effect relationship between management actions and supplied environmental service (e.g., Perrot-Maître 2006). In other cases, linking existing demand to potential supply may be achieved by supporting the determination, collection, and distribution of payments through a government agency, a private agency or multilateral/ international donors. Another possible agent intervention may consist of multilateral/ international donors and/ or the private sector providing funds for the design,

implementation, and/ or maintenance of a PES scheme. If these funds are used for payments to ES suppliers the multilateral/ international donors act as buyers representing the global community.

In most cases, though, the extent of agent intervention to reduce transaction costs has to go further if exchange is to be advantageous to both buyers and sellers. The public sector may have to define and defend the property right over the ES that is being bought and sold. This type of involvement may be combined with efforts contributed by research institutions. In cases where 'unowned' ES are targeted, the public sector may have to act as the representative of the broader community and be the buyer of ES to address free-riding. In taking this step, the government, through its use of funds raised by general or earmarked taxation, is the 'buyer' of ES on behalf of their citizens.

Demand for 'unowned' ES can be globally dispersed. If that is the case transaction costs can be lowered by the involvement of non-governmental organisations (NGOs). NGOs can act as a 'broker' to purchase ES by mobilizing demand through arranging to accept donations. Using a 'broker' to link globally dispersed demand to large numbers of potential suppliers reduces the costs of negotiation and makes a PES exchange mutually beneficial for buyers and sellers.

## 3.2    Type of returns received by sellers

Another way of distinguishing between PES schemes is by the type of returns sellers receive from their participation. Returns can be categorised as direct and indirect returns (e.g., Midgley et al. 2012). Direct returns to sellers can include monetary and/ or an in-kind payments. Sellers may additionally gain indirect returns such as income from selling cash crops that are planted as part of the scheme or on-site water-quality and aesthetic benefits arising from forest protection measures taken under the scheme. The net returns to sellers (producer surplus) are the difference between the total returns (direct and any indirect returns) sellers receive from their participation in the scheme and their individual marginal costs of ES supply. The net returns to buyers (consumer surplus) consist of the marginal benefits generated from the consumption of ES supply less the required payment to ES sellers.

## 3.3 Seller type

Another characteristic by which PES schemes may differ is the type of potential sellers that are included. In general, potential sellers are defined as those who have legal control over the provision of ES. This may include an individual who holds land (use/ utilization) rights; a community that jointly holds land (use/ utilization) rights or a government that holds land rights (Engel et al. 2008). If the government holds land and use/ utilization rights, the government may be both seller and buyer. For example, the government may act as a seller supplying ES within a national park and as a buyer representing the general public as the funds required for the payments would be sourced through compulsory taxation.

If communities have the control over ES supply the PES scheme has to specify how effort (marginal costs of supply) and total returns are to be distributed among the community members. Psychology theory (Fehr et al. 2002) and experience (Sommerville et al. 2010) show that the perceived fairness of this distribution is crucial for positive incentives to be effective. The distribution may be such that an equal share of the total returns is given to each household. Such a distribution may cause social tension if effort and/ or compliance differ across households. A related challenge that community-based PES schemes can face is 'elite capture' (Kellert et al. 2000). If community members with power (e.g., a village head) take a disproportionate share of the total returns, the trust and motivation of the relatively disadvantaged community members, and thus the effectiveness of the PES scheme to supply ES, diminishes (Zabel et al. 2010). Distributing in-kind, non-excludable and non-rival returns (e.g., social infrastructure such as roads, schools, hospitals, etc.) rather than monetary returns may help to reduce elite capture (Sommerville et al. 2010) but raises the question of how to punish community non-compliance (Milne et al. 2009). An alternative to distributing the returns equally across community members is to sub-contract households specifying individual activities to be taken and associated returns to be gained (e.g., Pagiola 2008). This circumvents the problems stated above but increases the transaction costs of a PES scheme.

### 3.4 Seller selection mechanism

As pointed out earlier, PES schemes need to be customized to local conditions. This is achieved by determining eligibility criteria that must be met by potential ES sellers. Eligibility criteria of participation delineate the geographic boundaries of a PES scheme and help ensure that the PES scheme goals can be achieved. These criteria may include, for example, type and condition of potential sellers' resource endowments/ capability to supply desired ES (e.g., only forests with a certain slope are eligible), their legal capacities (e.g., only households that have use rights to land are eligible), and their socio-economic characteristics (e.g., only households with an income below a certain threshold are eligible).

Once the eligibility criteria of participation have been established, a choice has to be made whether all potential sellers who meet these criteria will be accepted or whether further selection will be conducted. In some cases there is no choice. The desired ES may only be supplied if all potential sellers within a catchment participate. In others, the desired supply may allow for further selection. For instance, if the budget is limited, the potential for further selection is clear if the budget is otherwise exceeded. However, there are other reasons for extending the selection process even when the budget is adequate. These reasons will be discussed subsequently in the review of alternative ways of selecting potential sellers from those who meet the eligibility criteria.

One way to perform a further seller selection is by using the 'first-come best-dressed' principle (those who apply first in time are selected over late-comers). This approach is unlikely to be economically efficient because the timing of application is unlikely to be correlated with the net benefits generated by different suppliers. An alternative approach is to rank potential sellers with the goal to either minimize costs or maximize benefits of ES supply. One way to conduct such a ranking is to use an EBI. An EBI is usually based on a composite of several attributes of the environmental outcomes of a PES initiated environmental management strategy. Note that EBIs sometimes involve inputs as attributes as well as environmental conditions, that is, they are acting as a function that links actions to outcomes. The EBI values the relative merit of actions proposed by potential ES sellers in non-monetary terms using a scoring system. Examples of EBI

applications include EcoTender in Victoria (e.g., Eigenraam et al. 2005) and the Investment Framework for Environmental Resources – INFFER (Pannell et al. 2012).

The use of an EBI allows the comparison of alternative management actions by converting their relative merit into a common unit – the EBI. An EBI/Cost ratio (EBI/C) can be used to rank sellers' proposals. This approach is likely to increase the cost-effectiveness (increase in desired ES quantity/ quality at minimum costs) from the perspectives of the buyers or their agents of a PES scheme compared to applying the 'first-come best-dressed' principle[8]. Cost-effectiveness can help to reduce the extent of expenditure for a given ES supply target or maximise the supply of ES for a given budget. In the case of private buyers, this is not necessarily true. Private buyers who enjoy financial net returns from the contracted level of ES supply may invest those net returns in purchasing more ES. But they may also choose to spend them on other goods and services.

It has to be noted, that if the EBI is used to measure a bundle of ES it remains unclear if the EBI actually aggregates across the various component ES in a way that reflects the relative merit of each ES. Furthermore, an EBI is not necessarily based on public preferences. More often, it involves expert and stakeholder assessments of the relative merit of each outcome. As a result, benefits estimated in terms of an EBI may not coincide with the benefits enjoyed by the wider society. This implies that an EBI may not embody information on the scheme's marginal benefits enjoyed by the buyers. Hence, the use of an EBI/C bears a risk of being an economically inefficient mechanism of selecting sellers in that it does not ensure society is made better off. Even if an EBI is based on public preferences and does reflect the relative merit of an ES bundle, an EBI/C does not provide the information necessary to decide on the efficient quantity of ES that should be bought. Without information on the monetary value of the generated ES (as it is the case with an EBI/C) it remains unclear if the PES scheme achieves an increase in social well-being.

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[8] Noting the higher transaction costs associated with the use of an EBI.

An alternative is to use the principles of Benefit-Cost Analysis (BCA) (e.g., Hanley et al. 1993). In comparison to an application of an EBI/C, this approach values the benefits in monetary terms to make them directly comparable with costs. Sellers' proposals would be ranked by their marginal costs per unit of output and included into the PES scheme until the economically efficient quantity of ES supply has been reached. It has to be noted, though, that a budget constraint may limit the purchase of the efficient quantity of ES.

The BCA approach allows an assessment of a scheme's economic efficiency and its effect on the distribution of net returns between sellers and buyers. Neither the 'first come best dressed' nor the EBI/C approach allow for this depth of assessment. However, applying BCA principles requires estimating the benefits and their value in monetary terms, which increases the transaction costs of PES schemes.

Ranking sellers' proposals by their marginal costs per unit of output is straightforward in the case of PES schemes that generate a single output type. PES schemes that supply multiple output types require additional analyses. In that case, a ranking can be achieved by aggregating the multiple output types into a single index using the implicit prices estimated for each output type (if the marginal benefits of all output types are constant). Thus, the proposals can be ranked by their individual marginal costs per unit of indexed output and included into the scheme until the budget has been exhausted (if the quantity of total supply is smaller than the economically efficient quantity) or until the economically efficient quantity of total supply has been reached. As a result, the total net returns (total surplus) would be maximized.

Alternatively, a ranking can be achieved by expressing the merit of each proposal as a Benefit/Cost ratio (B/C)[9]. Proposals that achieve a B/C ratio greater than one would be ranked and included into the scheme until the budget has been exhausted (if the quantity of total supply is smaller than the economically efficient quantity) or until the

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[9] A B/C ranking and a ranking based on an output index are equivalent if the marginal benefits are constant across all output types since a B/C is equal to the inverse of the marginal costs per unit of indexed output multiplied by the sum of the implicit prices of all output types. That is, the resulting ranking order would be identical.

economically efficient quantity of total supply has been reached[10]. A B/C ranking ensures that suppliers with proposals that deliver the highest net benefits are contracted and allows the identification and exclusion of proposals that would generate a net loss to society.

In the case of diminishing marginal benefits, however, the implicit prices decrease with increasing output. If these changes are not proportional across all output types[11], the marginal costs per unit of indexed output vary with the changes in implicit prices through the changes in the indexed quantity of output. In the case of non-proportionally decreasing marginal benefits, the decrease in implicit prices has to be accounted for in the ranking procedure. Otherwise, sellers with individual marginal costs that are higher than the marginal benefits enjoyed by the buyers at the economically efficient quantity of ES supply might be included into the scheme. Even though they may generate a net benefit to society, economic efficiency could be improved by changing the ranking order.

The BCA approach can be applied in schemes that base the payment rate on individual marginal costs as well as in schemes where successful sellers are allowed to extract net returns.

## 3.5   Payment system

A key element in developing a PES scheme is the design of the payment system.

Choosing how the payment system is determined constitutes the first element in designing a payment system. Negotiating the payments directly between sellers and buyers is the most direct approach. The payments made have to be greater than the marginal costs of the sellers to supply ES (less any indirect return) and less than the marginal benefits of the supplied ES enjoyed by the buyers. If this is not the case neither the sellers nor the buyers have an incentive to participate. Trade will not take place. Hence, negotiated payments will be somewhere between the marginal costs of the sellers (less any indirect return) and the marginal benefits enjoyed by the buyers. The stronger

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[10] A ranking approach may be challenging if the inclusion of all proposals with B/C > 1 exceeds the budget constraint and the lowest ranked proposals have equal B/C .

[11] This includes cases in which the marginal benefits are diminishing for some but not for all output types.

the bargaining power of potential sellers (perhaps because there are small numbers of sellers who act together as a 'cartel'), the closer the payments will be to the marginal benefits enjoyed by the buyers. The stronger the bargaining power of the buyers (perhaps because of strong competition among sellers), the closer the payments will be to the marginal costs of the sellers. However, few PES schemes are characterised by such a low level of agent involvement that such direct negotiations between sellers and buyers occur[12]. In most PES schemes, agents determine the payment system, and collect, manage and distribute the payments.

The second element in designing a payment system is the development of a payment schedule. The effectiveness and the economic efficiency of a PES scheme will be influenced by the timing of the payments. Alternative payment schedules over time provide different incentives to sellers to fulfilling their contracts. Limited up-front payments followed by a sequence of follow-up payments made when milestones are achieved can reduce the risk of non-compliance across time (Pagiola 2008).

The third, fourth, and fifth elements in designing a payment system are the selection of a payment base (which indirectly determines the seller performance measure), the definition of the payment and the determination of a payment rate. Payments received by sellers (and paid by buyers[13]) are determined by a payment base (input used or output generated) and a payment rate[14]. The payment rate can be a uniform monetary amount set independently of marginal costs or marginal benefits of supply. Alternatively, it can be set to equal the marginal costs of supply, the marginal benefits of supply, or an amount between both. Payments can be either defined per unit of input/ or per unit of output (unit payment), or per total input/ or per total output (total payment).

Payments may be defined in terms of any of the following:

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[12] For example, an agent provides scientific knowledge so that the ES being sold and bought can be adequately defined.

[13] In case the determination of the payments paid by buyers is part of the PES scheme.

[14] This explanation refers exclusively to payment rates in monetary terms. It has to be noted that, in general, in-kind payment rates can be converted into monetary payment rates.

- A uniform payment per unit of input measured in bio-physical terms[15] determined independently of marginal costs or marginal benefits of supply (P-I)

  *For example, all suppliers participating in a PES scheme that aims to enhance biodiversity receive the same payment of $X per hectare of afforested area.*

- A uniform payment per unit of output supplied estimated in bio-physical terms determined independently of marginal costs or marginal benefits of supply (P-O)

  *For example, all suppliers participating in a PES scheme that aims to enhance biodiversity receive the same payment of $Y per percentage increase in the population of a certain indicator species.*

- A payment equal to the marginal benefits (estimated in monetary terms) generated per unit of input (or per total input) measured in bio-physical terms[15] (P-$MB/I)

  *For example, all suppliers participating in a PES scheme that aims to enhance biodiversity receive an (individualized) payment equal to the marginal benefits (expressed in monetary terms) enjoyed by buyers that are generated per hectare (or per total hectares) of afforested area.*

- A payment equal to the marginal benefits (estimated in monetary terms) generated per unit of output (or per total output) measured in bio-physical terms (P-$MB/O)

  *For example, all suppliers participating in a PES scheme that aims to enhance biodiversity receive an payment equal to the marginal benefits (expressed in monetary terms) enjoyed by buyers that are generated per percentage increase (or per total percentage increase) in the population of a certain indicator species.*

- A payment equal to the marginal costs (estimated in monetary terms) incurred by sellers per unit of input (or per total input) measured in bio-physical[15] terms (P-$MC/I)[16]

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[15] Inputs include, for example, hectare of afforested area, trees, people, technical equipment, seeds, and management actions such as changed agricultural practices.

[16] The discussion of payment systems that are based on individual marginal costs of supply assumes that the buyer (or their agents) knows the true marginal costs of supply. As discussed subsequently in this report, a reverse auction can be used to estimate individual marginal costs of supply. It has the potential to reduce informational rent but it is unlikely that informational rent is eliminated completely (Ferraro 2008).

*For example, all suppliers participating in a PES scheme that aims to enhance biodiversity receive an (individualized) payment equal to the marginal costs (expressed in monetary terms) incurred by suppliers per hectare (or per total hectares) of afforested area.*

▪ A payment equal to the marginal costs (estimated in monetary terms) incurred by sellers per unit of output (or per total output) supplied estimated in bio-physical terms (P-$MC/O)

*For example, all suppliers participating in a PES scheme that aims to increase biodiversity receive an (individualized) payment equal to the marginal costs (expressed in monetary terms) incurred by suppliers per percentage increase (per total percentage increase) in the population of a certain indicator species.*

The first two alternatives apply uniform payment rates: uniform payments per unit of input measured in bio-physical[15] terms (P-I) and uniform payments per unit of output estimated in bio-physical terms (P-O), respectively. For both alternatives, the net returns per unit of input or output received by sellers are the differences between the unit payments (in addition to any indirect returns) and their individual marginal costs of supply per unit of input or output, respectively. Marginal costs of supply may differ across sellers due to, for example, differences in land productivity, skill level, local climate, or degree of motivation. Additionally, the indirect returns enjoyed by each seller may differ. Consequently, the net returns received by sellers for the same amount of input or output vary with their individual marginal costs of supply and the indirect returns each seller enjoys. Lower cost suppliers gain higher net returns than higher cost suppliers. This correlation may be influenced by potential differences in indirect returns across sellers. A higher cost supplier with higher indirect returns may gain higher net returns than a lower cost supplier with lower indirect returns. Put simply, unit payments based on a uniform payment rate as applied in P-I,O payment systems do not imply that all sellers receive the same net returns for the same amount of input used or output generated.

If the marginal costs of supply outweigh the total returns for a substantial portion of potential sellers a scheme's effectiveness of supplying ES will be low. In a scheme that is characterised by voluntariness, sellers who experience marginal costs that outweigh their total returns would be made worse-off by engaging in the scheme and so have no

incentive to participate. If the scheme was compulsory, the forced sellers experiencing a net loss would most likely 'do a bad job'. If the total returns under P-I,O payment systems for at least one seller are greater than their marginal costs of supply, more output could have been supplied for the same budget. Hence, from the perspective of the buyers (or their agents), the cost-effectiveness of the scheme could be improved. Of course, improving a scheme's cost-effectiveness implies a reduction of the net returns that can be secured by the sellers. An increase in a scheme's cost-effectiveness has the potential to increases the supply of ES for a given budget but decreases sellers' net returns.

A key difference between P-I and P-O payment systems stems from the possibility that the quantity of output generated per unit of input may vary across sellers. In the extreme case, (some) inputs used by (some) sellers may be ineffective in producing outputs. P-I payment systems may be effective in achieving a high seller participation rate but they may be ineffective in delivering ES such that the participating sellers may not generate any output (ES) through their PES actions. A scheme that is ineffective in delivering ES is economically inefficient, irrespective of the extent of PES participation. Society is made worse-off.

PES schemes that are based on P-I,O payment systems may allow all sellers who meet the eligibility criteria to participate. The criteria for eligibility to participate may be based on the goals of the scheme and the policies driving it. The criteria may include, for example, sellers' capacity to supply desired ES, their legal standing and/ or their socio-economic characteristics. An alternative is to cap participation by a budget constraint or a bio-physical target constraint (input or output goal). Either way, information about the marginal benefits generated through ES supply is not part of the eligibility determination. Such PES schemes bear a risk of being economically inefficient in that they could make society worse-off if suppliers whose individual marginal costs are higher than the marginal benefits that are generated at the economically efficient level are included into the scheme.

Finally, P-I,O payment systems may set the payment rate to be relatively large compared to the marginal benefits generated per unit of input (or total input) or unit of output (or total output), respectively. As a result, the net returns to buyers could be negative. If the

scheme is voluntary buyers would not participate. If, however, a government acts as the representative of the broader community and force their citizens through their power to raise funds through general taxation to be 'buyers' of ES, the scheme may still go ahead. Sellers who generate a net loss to society have an incentive to participate if the payment rate is greater than their individual marginal costs of supply.

The following two figures demonstrate the effects of a P-O payment system for a single output PES scheme on economic efficiency and distribution of net returns between sellers and buyers. Figure 1 shows a scenario in which the uniform payment rate (P) is relatively large compared to the marginal benefits enjoyed by buyers per unit of output (the payment rate intersects the diminishing marginal benefit curve at a relatively high level). The economically efficient quantity of output would be at $Q_e$. However, sellers have an incentive to supply output up to $Q_i$[17]. This scenario would be highly attractive to sellers but highly unattractive to buyers. The sellers' net return would be positive (area BDP) whereas the net return received by buyers would be negative (area APE - ECD) if they participated.

Figure 2 shows a scenario in which the payment rate (P) is relatively small compared to the marginal benefits enjoyed by buyers per unit of output (the payment rate intersects the diminishing marginal benefit curve at a relatively low level). Sellers receive a net return represented by area BCP. The net return to buyers is represented by area APCE. The low payment rate does not achieve the economically efficient quantity of output ($Q_e$) since this scheme would not be attractive to sellers whose marginal costs are smaller than the payment rate. Only $Q_i$ would be supplied by voluntary sellers.

It has to be stressed that without collecting information on individual marginal benefits and individual marginal costs of supply the PES scheme designers would be ignorant of the effects of their schemes on economic efficiency and net return distribution as demonstrated above.

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[17] $Q_i$ will only be supplied if the PES scheme is funded by government taxation.
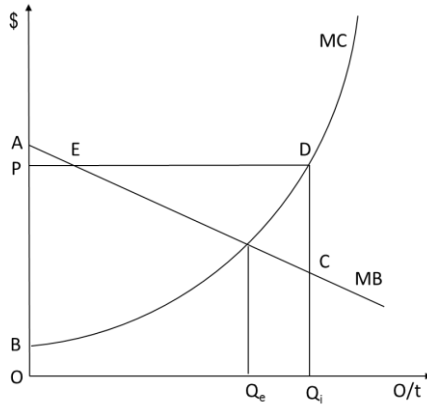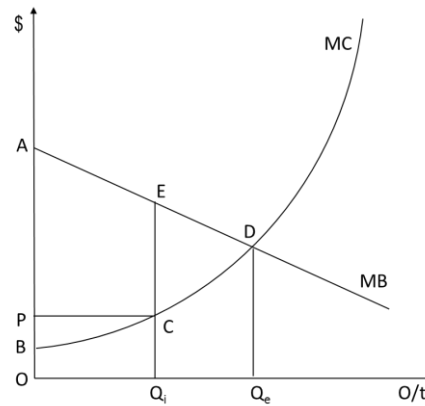
Figure 1                    Figure 2

The next two alternatives include payment rates equal to the marginal benefits (estimated in monetary terms) generated per unit of input (or per total input) measured in bio-physical[15] terms (P-$MB/I), or per unit of output (or per total output) measured in bio-physical terms (P-$MB/O). That is, the payment rate is equal to the marginal benefits enjoyed by buyers that are generated by sellers through the PES scheme initiated actions.

The marginal benefits generated for the same quantity of input by each supplier may vary since the effectiveness of the inputs they each use to generate outputs may differ. Information (for each supplier) on the effectiveness of inputs used to generate outputs (production function) enables the conversion of payment rates per unit of input (or per total input) into payment rates per unit of output (or total output) by means of a bio-economic model.

If the marginal benefits enjoyed by buyers are constant, P-$MB/I,O payment systems ensure that none of the sellers is paid more than the generated marginal benefit enjoyed by the buyers. Hence, sellers whose individual marginal costs are higher than the constant marginal benefits (the payment rate) have no incentive to participate (if the scheme is voluntary).

P-$MB/I,O payment systems that are faced with diminishing marginal benefits must decide how to allocate the diminishing marginal benefits across supplier. This requires, in turn, a decision about the ranking of proposals. Applying the 'first-come-best-dressed'

principle would likely result in an economically inefficient allocation of resources. Alternatively, if the suppliers are ranked by their individual marginal costs for the same quantity of output the total net returns (total surplus) would be maximized. This implies that the lowest cost supplier would earn the greatest net returns. The net returns to the sellers would diminish with increasing individual marginal costs. Figure 3 illustrates an example focusing on two suppliers. The net returns to the first ranked seller that would supply O-$Q_a$ is represented by the area BCHA, the net returns to the last ranked seller that would supply $Q_a$-$Q_e$ is represented by the area DFG.

Figure 3 further demonstrates that all the net returns are gained by the sellers (area BFA if ES supplied at $Q_e$). The net returns to the buyers are zero. That is, the cost-effectiveness from the perspective of the buyers (or their agents) is low. Furthermore, sellers would have no incentive to supply output beyond $Q_e$ since they would make a loss. If the suppliers are ranked by their individual marginal costs for the same quantity of output, this payment system ensures that the PES scheme makes society better-off.

A special case are P-$MB/I payment systems that apply a payment rate based on the average of the individual marginal benefits generated across a wide group of heterogeneous suppliers per unit of input. Such a payment system is likely to imply constant marginal benefits per unit of output and ignores differences in the effectiveness of inputs used to generate outputs. Sellers who employ highly productive inputs would generate more outputs per unit of input (or total inputs) than sellers who employ less effective inputs. Hence, the marginal benefits generated by the same quantity of inputs differ across sellers.

The first consequence would be that some sellers may produce very little or no output per unit of input (or total input). The second consequence would be that sellers who generate individual marginal benefits that are lower (higher) than the average marginal benefits generated across all sellers receive higher (lower) direct returns than they would if the differences in input effectiveness were recognised. A uniform payment rate (in the form of an average payment rate) paid to all sellers independent of their individual contribution to the overall supply raises questions about the fairness of the payment system. The third consequence would be that if the assumption of constant marginal benefits does not hold,

the scheme would overpay high cost suppliers and underpay low cost suppliers compared to a scheme that accounts for diminishing marginal benefits and ranks sellers by their individual marginal costs.
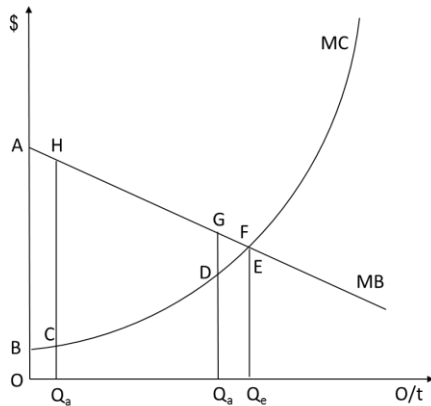


Figure 3

All alternative payment systems discussed so far explicitly ignore the marginal costs of supply. The final two alternatives discussed in this report are based on a payment rate equal to the marginal costs (estimated in monetary terms) incurred by sellers per unit of input (or per total input) measured in bio-physical terms[15] (P-$MC/I), or per unit of output (or per total output) measured in bio-physical terms (P-$MC/O). The payment rate can be based on the individual marginal costs (individual payment rate) or on the average of individual marginal costs across all sellers (average payment rate). The use of an individualized payment rate implies that a payment rate per unit of input (or per total input) can be converted into a payment rate per unit of output (or total output) by means of a bio-economic model.

An individualized payment rate ensures cost-effectiveness (from the perspective of the buyers or their agents) because each supplier is paid a rate equal to their individual marginal costs of supply per unit of input or output (or per total input or output)[18]. Hence, sellers forgo any net returns (ignoring any indirect returns). All net returns (area ABF if

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[18] Perfect price discrimination.

ES supplied at $Q_e$ in Figure 3) are secured by the buyers (or their agents). That is, the cost-effectiveness from the perspective of the buyers or their agents is high. The net return to the sellers is zero. Sellers would have no incentive to supply beyond $Q_e$ since they would make a loss.

A concern advanced regarding this payment rate is perceived fairness (e.g., Ferraro 2008, Muñoz-Piña et al. 2008, Tan 2011). Specifically, not paying the same payment rate to all participants may lead to social conflict and/ or the rejection of the PES scheme. PES scheme participants may not understand the effect of alternative payment systems on the net returns they receive. As discussed above, payment rates based on individual marginal costs result in an equal distribution of net returns for the same quantity of input or output to sellers even though the payment rate paid to individual sellers differs (ignoring any indirect return).

By contrast, payment systems based on uniform payment rates, such as P-I/ P-O payment systems or schemes with payment rates based on marginal benefits (P-$MB/I,O), do not distribute net returns for the same quantity of input or output equally across sellers. The net returns received by each seller vary with their individual marginal costs of supply.

An alternative are P-$MC/I,O payment systems that apply a payment rate equal to the average of the individual marginal costs across all sellers. This may reduce the effectiveness of the scheme since, by construction, some sellers would face individual marginal costs that are higher than the average of the individual marginal costs across all sellers. These sellers have no incentive to participate in the scheme even though they might produce net benefits to society if included into the scheme. On the other hand, sellers whose individual marginal costs are lower than the average marginal costs would extract net returns.

The economic efficiency of individualized P-$MC/I,O payment systems can be ensured if the individual marginal costs of supply are known to the buyer or their agents and if the contracted supply is restricted by demand[19]. That is, the marginal benefits generated

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[19] In case of a P-$MC/I, an additional condition of achieving economic efficiency is that the inputs used are effective in producing the desired amount and quality of ES.

through actions initiated by the PES scheme are greater than the marginal cost of supply. Hence, the most important advantage of individualized P-$MC/I,O payment systems over other payment systems discussed previously is that they are based on the estimation of individual marginal costs. P-$MC/I,O payment systems, combined with a ranking approach that is based on BCA principles, enables the exclusion of sellers whose individual marginal costs outweigh the marginal benefits enjoyed by the buyers at the economically efficient quantity of supply. Excluding those sellers ensures that a PES scheme is economically efficient as it makes society better-off.

The key difference between P-$MB/I,O and P-$MC/I,O payment systems is the distribution of net returns between sellers and buyers (or their agents). P-$MB/I,O payment systems distribute net returns in favour of sellers (the net returns to buyers or their agents are zero), while individualized P-$MC/I,O payment systems distribute the net returns in favour of buyers or their agents (the net returns to the sellers are zero). The magnitude of the net returns received by sellers and buyers (or their agents), respectively, depends on the price elasticity of demand and supply.

An alternative to P-$MC/I,O payment systems is to set the payment rate for all sellers to the marginal costs per unit of output of the highest cost (but still economically efficient) supplier. This supplier would be selected by ranking all potential sellers by their individual marginal costs per unit of output. The marginal costs of the last supplier that would be accepted into the scheme would have to be equal to the marginal benefits enjoyed by the buyers at the economically efficient quantity of ES supply. Setting the payment rate in that way allows sellers to extract the type of net returns that are enjoyed by sellers in competitive markets. Allowing sellers to extract individual net returns reduces the overall resources available to supply ES elsewhere (or to buy other goods and services). Yet, this payment system provides an opportunity for both sellers and buyers (or their agents) to extract net returns - the net returns are shared. As shown in Figure 4, the payment rate would be P. The net returns to the sellers would be equal to the area BCP. Buyers would gain net returns that are equal to the area PCA. The magnitude of the net returns received by sellers and buyers (or their agents), respectively, depends on the price elasticity of demand and supply. In the extreme case of a perfectly elastic demand, all net returns would be earned by the sellers.
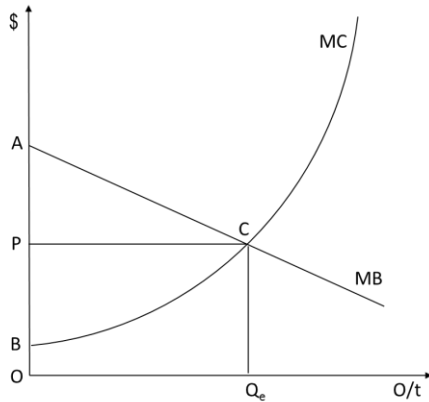
Figure 4

## 3.6 Seller performance measure

The choice of the unit of payment indirectly determines the way seller performance has to be assessed. The performance of ES sellers can be assessed using input-based or output-based performance measures (e.g., Latacz-Lohmann et al. 2005, Engel et al. 2008, Hanley et al. 2012). Input-based payment systems demand input-based performance measures. Accordingly, output-based payment systems demand output-based performance measures. Yet, payment systems that assess marginal benefits and marginal costs allow a conversion of payment rates per unit of input (or per total input) into payment rates per unit of output (or total output) by means of bio-economic models. Consequently, both input-based and output-based performance measures can be used regardless whether an input or output based unit of payment (or total payment) is used.

Some PES schemes do not assess seller performance. It must be stressed that not assessing seller performance makes it impossible to make payments conditional on the delivery of ES. The impossibility of conditioning payments on ES delivery is likely to result in a small or no increase in ES supply. Society may be made worse-off by such schemes.

Input-based performance measures assess seller performance on actions (e.g., the number of trees planted) expected to supply desired ES (e.g., quantity of soil erosion reduction). In contrast, output-based performance measures assess the quantity of production of

desired ES directly (e.g., quantity of soil erosion reduction). Input-based performance measures require the design of bio-physical models to establish the cause-effect relationships between actions and ES supply. If the relationship between actions and supplied ES cannot or is not quantified, the magnitude of ES provision remains unknown at least in the short term. For the majority of ES, output-based performance measures are more difficult and hence more costly to establish and to monitor due to complexities in time and space. As a result, conditionality can be difficult to determine. However, this is not true for all ES. For example, in cases where the ES is defined as an increase in the numbers of certain animal species it is easier to count the animals (output) than to monitor hunting restrictions (input) or a mixture of both (e.g., Frost et al. 2008).

The type of the performance measure also determines the distribution of risks between sellers and buyers (or their agents). Output-based performance measures are riskier to sellers (e.g., Latacz-Lohmann et al. 2005, Hanley et al. 2012) compared to input-based performance measures that are riskier to buyers (or their agents). Who is best placed to bear the risk of failure? Sellers may lose payments due to external effects (e.g. droughts, pests, changes in market prices), which might reduce sellers' willingness to participate. If there is genuine risk in delivery the seller is expected to require a risk premium to enter a PES contract that evaluates performance on an output-based measure. It may well be that it is more efficient for buyers (if represented by the government) to bear the risk of delivery if they have a large portfolio of projects and hence can spread the risk across all of them, rather than a supplier, for whom it is an all or nothing status.

### 4.    Estimating marginal cost of ES supply

Individual marginal costs of supply are only known by potential sellers. As a consequence, they can be difficult for an external agent to estimate. Put simply, information on the marginal costs is 'hidden' from the buyer and the agents (Ferraro 2008). One way of collecting information on marginal costs is to use market data or transfer information about marginal costs estimated somewhere else as a proxy. Both ways are crude and will at best allow the approximation of the marginal costs of suppliers on average across a wide group of potentially heterogeneous suppliers. Without individual marginal cost data, BCA principles and EBI/C (both of which are based on individual marginal costs) cannot be used to rank and select individual proposals.

An effective way of estimating individual marginal costs is to use reverse auctions (e.g., Latacz-Lohmann et al. 2005, Schilizzi et al. 2007). In a reverse auction, potential sellers competitively tender to provide ES in return for a payment (Latacz-Lohmann et al. 2005). That is, marginal cost differences across potential ES sellers can be detected. The payment can be defined as a unit payment (marginal costs of supply per unit of input or output) or as a total payment (marginal costs of supply per total input or output). Reverse auctions involving multiple inputs and multiple outputs usually apply total payments. That is, the potential seller tenders to offer a bundle of inputs or outputs in exchange for a total payment.

The competition created within the reverse auction discourages strategic behaviour. Potential sellers are more likely to reveal their true individual marginal costs of supply since they face a trade-off between the level of the proposed payment and the probability of being contracted (Latacz-Lohmann et al. 2005). Hence, a reverse auction can reduce costs associated with 'hidden information' and thus has the potential to increase the cost-effectiveness of a PES scheme that applies a payment rate based on individual marginal costs (Ferraro 2008). It has to be noted though that the degree to which potential sellers reveal their true marginal cost of supply depends on the incentive structure of the reverse auction. A reverse auction has the potential to reduce informational rents gained by sellers who inflate their true individual marginal costs. However, the process cannot

eliminate them altogether (e.g., Ferraro 2008). Consequently, the individual marginal costs of supply estimated by means of a reverse auction include not only the opportunity costs of forgone benefits from alternative land use (e.g., planting trees instead of harvesting crops), costs to fulfil the contract (e.g., purchase of seedlings, labour), and a risk premium but potentially a component of an informational rent. In a budget constrained scheme financed through public spending, informational rent reduces the quantity of ES that can be purchased. If the available budget is smaller or equal to the budget required to purchase the economically efficient quantity of output, informational rent reduces total net benefits. Since the economically efficient quantity cannot be purchased the net benefits to society cannot be maximised.

Estimating marginal costs by means of a reverse auction has also the potential to indirectly include any indirect returns enjoyed by each seller into the proposed payments. Potential sellers may account for indirect returns such that they may off-set some of the marginal costs of supply.

Experience shows that successfully conducting a reverse auction requires informed and skilled participants (e.g., Eigenraam et al. 2005, Wang et al. 2012). This implies that training of participants is an essential part of organizing a reverse auction. As a result, the transaction costs of PES schemes that use reverse auctions increase. Other challenges to overcome are insufficient competition among sellers including the potential for collusion (Latacz-Lohmann et al. 2005).

## 5. Examples of PES schemes

### 5.1 Payments for environmental services in Costa Rica[20]

The PES scheme in Costa Rica is an ongoing country-wide program. The ES that are supplied are recognized in Forest Law No. 7575 and include mitigation of greenhouse gas emissions, hydrological services, biodiversity conservation, and preservation of scenic beauty through forest conservation and management.

*Type and degree of agent intervention:*
The PES scheme was developed by the Costa Rican Government in 1996[21]. The Forest Law No. 7575 provides the legal base for the scheme and the establishment of the Fondo Nacional de Financienmiento Forestal (FONFAFIO), a semi-autonomous agency with independent legal status. FONFAFIO includes representatives of the public and the private sector. The payments made by the private companies and the international community represented by Global Environment Facility (GEF), Conservation International and the World Bank (WB) are management by FONFAFIO. The Costa Rican Government additionally acts as a buyer, representing water and fuel users by means of a water tariff and a fossil fuel sales tax.

*Buyer type:*
Buyers include private companies (hydro-power companies, water bottlers, irrigation water users, hotels, and agribusiness) and municipal water suppliers. Contracts with private companies and municipal water suppliers are usually for five years and are renewable by mutual agreement. A third group of buyers are the users of water and fossil fuel. Water users participate in the scheme through a water tariff and fossil fuel users through a fossil fuel sales tax introduced by the government[22]. An earmarked portion of the water tariff and the fuel sales tax is used to fund the PES scheme. A fourth buyer is

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[20] The review of the PES scheme in Costa Rica is based on Pagiola (2008). The PES scheme may have been modified since 2008.
[21] The PES scheme replaced an existing system of reforestation and forest management payments.
[22] Payments to FONFAFIO made under voluntary agreements are deductable from the water tariff to avoid double payment.

the international community represented through funds provided by Conservative International, a WB loan, and a GEF grant. The GEF grant is not intended to be renewable, which raises the question of long-term financing. Up until 2008, an involvement of the tourism industry as buyers had not been successful and payments for the ES 'preservation of scenic beauty' have not been secured since free-riding provides a considerable challenge.

*Seller type:*

Sellers include individuals and groups of farmers with and without formal land titles outside protected areas[23]. In the case of groups, contracts are signed with the groups as well as with each individual farmer within each group. This increases the transaction costs of the PES scheme but reduces problems associated with partial compliance.

*Seller selection:*

Conditions to participate are the presentation of a sustainable forest management plan designed by a licensed forester describing the current and planned land use, information on property rights, biophysical indicators, plans for preventing illegal hunting, illegal harvesting, and forest fires as well as monitoring schedules. Everyone who meets the basic eligibility criteria qualifies to participate. Yet, seller participation is capped by a budget constraint. Information on marginal costs of supply and generated marginal benefits is not part of the eligibility determination.

*Payment system:*

The PES scheme uses a P-I payment system as it applies a country-wide uniform payment per hectare of enrolled area of land per time period[24]. The payment rate and the payment schedule varies across different types of contracts available to sellers (forest conservation contract, timber planation contract, agro-forestry contract). Forest conservation contracts stipulate equal annual payments after an up-front payment; timber plantation contracts stipulate decreasing payments over five years. The payment rates

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[23]Landowners outside protected areas are eligible if they have not yet been compensated for land that became part of the protected area.

[24] There are two minor exceptions with higher payments in the Rio Segundo catchment and lower payments in the Rio Platanar catchment.

under voluntary agreements must be negotiated between the buyers and FONFAFIO. Payments to sellers are set annually by FONFAFIO.

*Seller performance measure:*

The scheme assesses performance using input-based indicators for different types of contracts. For example, indicators for conservation contracts include compliance with hunting restrictions and with the ban of felling trees in forests that are enrolled in the PES scheme.

*Type of return received by seller:*

Sellers receive direct returns as monetary payments and possibly indirect returns as a result of management actions taken as part of the scheme. For example, sellers who signed a forest protection contract may receive indirect returns from living in the improved environmental conditions that result from the forest protection measures taken.

*Conditionality:*

Conditionality is built into the scheme through a monitoring system and a set of specified penalties for noncompliance. Initial payments are made up-front but subsequent payments are conditional upon compliance.

*Voluntariness:*

The participation of sellers is voluntary. Agreements between buyers such as private companies and municipal water suppliers and FONFAFIO are voluntary. Water and fossil fuel users cannot reject their participation in the scheme. The water tariff and the fossil fuel sales tax used to fund FONFAFIO are compulsory.

*Additionality:*

It is difficult to determine the magnitude of additionally supplied ES secured by this PES scheme. Firstly, assessing additionality would require the establishment of a baseline and a cause-effect relationship between management actions and supply of ES. Secondly, it is difficult to disentangle the effects of the scheme from other policies such as the ban on forest clearing (also introduced in 1996) or from changes in economic conditions that make participating in the scheme comparatively more or less profitable for suppliers. The extent to which the scheme has generated additional ES is therefore unknown. Yet, one explanation why forest conservation contracts have been more attractive than timber

plantation contracts may be the small or zero marginal costs of forest protection management actions undertaken through the scheme. It has to be noted though that additionality was not a stated goal of the Costa Rican Government in implementing the scheme.

*Transparency:*

The available information is not sufficient to assess the level of transparency of the scheme.

*Conclusion:*

This PES scheme is characterised by voluntariness and conditionality. The extent to which the scheme has generated additional ES is unknown. The high demand of forest conservation contracts (demand has outstripped the funds available for payments) suggests that the total returns received by sellers is larger than the individual marginal costs of supply. That is, the high participation rate provides evidence of the scheme being effective in recruiting sellers. Yet, it is unknown how effective the inputs used are to generate the desired ES. The scheme is only as effective in supplying the desired ES as the inputs are in generating them.

The net returns vary across sellers with their individual marginal costs of supply and the indirect returns each seller enjoys even though the payment rate is the same for all sellers within the same contract type. If the total return received by at least one seller is greater than their marginal costs of supply, more ES could have been supplied for the same budget. Hence, the cost-effectiveness of the scheme (from the perspective of the buyers or their agents) could be improved. Of course, improving the cost-effectiveness of the scheme reduce the net returns that can be secured by the sellers. Since the PES scheme does not involve the estimation of individual marginal costs the overall cost-effectiveness cannot be assessed. Naturally, the cost-effectiveness of this scheme not only depends on individual marginal costs but also on the effectiveness of the inputs used to generate outputs. A low level of effectiveness would result in a low level of cost-effectiveness.

The seller selection ignores marginal costs and marginal benefits of supply. It remains unknown if the marginal costs of supply for any of the sellers are larger or smaller than the marginal benefits they each generate per unit of input. The scheme thus bears a risk of

being economically inefficient in that it could make society worse-off if suppliers' marginal costs are greater than the marginal benefits enjoyed by the buyers at the economically efficient quantity of supply. Additionally, if the marginal benefits generated per unit of input vary across sellers and the uniform payment rate is relatively low compared to the average of suppliers' marginal costs then only low cost suppliers participate (voluntarily). Suppliers whose individual marginal costs are greater than the total returns they receive have no incentive to participate even though they may have the potential to generate comparatively large net marginal benefits per unit of input.

## 5.2  Payments for environmental services in Lam Dong Province, Vietnam[25]

The PES scheme was initiated in Lam Dong Province in 2008 by the Vietnam Government and implemented under the Government's Decision 380 on the Pilot Policy for Payment for Forest Ecosystem Services (The Prime Minister 2008). In January 2011, Decision 380 was replaced by a national decree applied to the whole country: Decree on the Policy for Payment for Forest Environmental Services (The Prime Minister's Office 2010). The scheme supported the production of forest ES. The ES targeted by the pilot PES scheme included water source regulation and provision, soil protection, reduction of erosion, protection against sedimentation of reservoirs, and preservation of landscape aesthetics.

*Type and degree of agent intervention:*

The Vietnamese Government, represented by the Forest Protection and Development Fund, was the main agent. The PES scheme was regulated by Decision 380, which defined the ES, identified buyers and sellers, stipulated the rights and responsibilities of buyer and sellers and regulated the management of the payments. The buyers were obligated by law to pay for ES as defined by Decision 380. The payments made by the buyers were collected and distributed by a fund, the Forest Protection and Development Fund. Decision 380 also provided the option for direct payments between buyers and sellers.

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[25] The review of the PES scheme in Lam Dong Province in Vietnam is based on Tan (2011).

*Buyer types:*

The buyers were stipulated by Decision 380. They included hydropower companies, water supply companies, and ecotourism companies.

*Seller types:*

All sellers were stipulated by Decision 380. The sellers were households and individuals with assigned legal rights to forest. Households and individuals without legal rights to forest had the opportunity to participate as subcontractors of the government. That is, in cases in which the government and not households or individuals had the legal rights to forest the government was the ES seller. Another entities involved in supplying ES were state owned forest companies and management boards. Again, the government, represented by these forest companies and management boards, was a seller.

*Seller selection:*

All sellers stipulated by Decision 380 were offered to participate in the PES scheme.

*Payment system:*

The payment system was determined by the government in consultation with some of the stakeholders and was informed by an estimation of aggregate marginal benefits of ES supply[26]. The estimated aggregate marginal benefit was divided by the total area (in hectares) of each catchment to estimate the average marginal benefits per hectare within a specific catchment. The payment rate received by sellers was determined as the average of the marginal benefits generated per hectare of enrolled land. Hence the PES scheme used a P-$MB/I payment system.

Decision 380 stipulated the multiplication of the per hectare benefit by a coefficient that differentiated forests by type (production, protection or special use forest), quality (rich, moderate, poor, or secondary forest) source (natural or planted forest) and level of human

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[26] A range of studies was conducted to estimate the aggregate benefits of ES supply (an overview is given by Nguyen et al. 2011).

impact (high or low)[27]. That is, the plan was to condition the payment rate on these differentiating factors. This factor would have accounted for differences in the effectiveness of different forest areas in their capacity to generate ES. That is, possible differences in marginal benefits generated by sellers would have been reflected in the payment rate to some extent. The aim of introducing a coefficient was to achieve equity and fairness in the distribution of net returns. Interestingly, the pilot communities in Lam Dong Province decided against applying this coefficient due to equity concerns.

The generated aggregate marginal benefits differed across catchments. As the payment depended on the generated aggregate marginal benefits of ES supply, sellers in different catchments received different payment rates.

*Seller performance measure:*

The performance of sellers was assessed using an input-based measure (quality of forest protection work). A range of studies were conducted to estimate cause-effect relationships between contracted management actions and ES supply (an overview is given by Nguyen et al. 2011).

*Type of return received by sellers*

Sellers received direct returns as monetary payments and in-kind payments (working clothes to patrol forests). They possibly also received indirect returns from capacity building and from forest products resulting from the protection measures taken as part of the PES scheme.

*Conditionality:*

Payments were designed to be conditional on fulfilling responsibilities according to Decision 380 and the signed contracts. The PES scheme was set up such that payments were withheld, in full or partially, if contracts were breached. The rights and responsibilities of sellers and buyers were stipulated in Decision 380. Yet, interviews

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[27] The Decree on the Policy for Payment for Forest Environmental Services adjusted the factors that determine this coefficient. The factors forest quality and human impact were replaced by forest owner (capacity to generate ES) and the level of difficulty or easiness in forest management (social and geographic factors) (The Prime Minister's Office 2010).

conducted by Burchards (2010) revealed that the sellers did not view the payments as truly conditional on the supply of ES (Phothisat et al. 2013).

*Voluntariness:*

Seller participation was voluntary. For buyers, stipulated by Decision 380, participation was compulsory. That is, the buyers were obligated by law to pay for ES as defined by Decision 380.

*Additionality:*

The information available did not disclose the extent to which the PES scheme supplied additional ES.

*Transparency:*

A wide consultation and participation process was conducted. This may have supported transparency. Yet, only a small group of sellers was involved in the scheme's development. Participation in the PES scheme design process was largely limited to buyers. Even though buyers were consulted during the scheme development phase the quality of the ES they had to pay for was not clearly communicated. However, buyers had the right to challenge the obligation to pay if the sellers did not deliver the contracted quality or quantity of forest protection. Sellers were not included in the determination of the payment rate they were offered.

*Conclusion:*

The degree of conditionality of this PES scheme remains unclear. Formally it was designed to be characterised by conditionality. Yet, sellers might not have perceived the payments as truly conditional on the supply of ES. The degree of transparency of the PES scheme remains unclear and the available information does not specify the extent of additional ES that were supplied under the scheme.

The scheme used a P-$MB/I payment system based on the average of the marginal benefits generated per hectare of enrolled land. Hence the scheme was designed to allow for net returns to be secured by sellers. Allowing sellers to secure net returns implies that

the cost-effectiveness from the perspective of the buyers was low. The distribution of the available net returns favoured the sellers. Sellers with low marginal costs of supply received higher net returns than those with higher marginal cost of supply (ignoring indirect returns).

The use of a P-$MB/I payment system has the potential to ensure an improvement in social well-being. Of course, this is only true if the inputs are effective in delivering additional ES and the estimated aggregate marginal benefits coincide with the generated true aggregate marginal benefits generated under the PES scheme.

Yet, this payment system ignored possible differences in the effectiveness of inputs used to generate output. Hence, the generated marginal benefits generated per hectare of enrolled land may have differed across sellers. Some sellers may have produced very little ES per hectare of enrolled land. Additionally, sellers who generated individual marginal benefits that are lower (higher) than the average marginal benefits generated across all sellers receive higher (lower) direct returns than they would have if the differences in input effectiveness would have been accounted for. Finally, if marginal benefits were not constant (but diminishing), the scheme would have overpaid high cost suppliers and underpaid low cost suppliers compared to a scheme that accounts for diminishing marginal benefits and ranks sellers by their individual marginal costs.

The coefficient stipulated by Decree 380 to differentiate payment rates might have accounted for differences in the effectiveness of different forest areas in their capacity to generate ES. That is, possible differences in marginal benefits generated by sellers might have been reflected in the payment rate to some extent. However, this differentiation was not applied in Lam Dong Province.


## 5.3 Payments for environmental services in Los Negros, Bolivia[28]

The ongoing PES scheme in Bolivia was initiated in 2003 by the Fundación Natura Bolivia, a local NGO. The ES this scheme aims to generate are the protection of exiting

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[28] The review of the PES scheme in Bolivia is based on Asquith *et al.* (2008). The PES scheme may have been modified since 2008.

cloud-forest habitat for migratory species and the stabilization of dry-season water supply through forest and grassland[29] conservation.

*Type and degree of agent intervention:*

The PES scheme is organised and promoted by the Fundación Natura Bolivia supported by funding from external donors. The Municipality of Pampagrande acts as a buyer representing the inhabitants of the community of Los Negros. The environmental committees of Santa Rosa and Los Negros who represent sellers and buyers, respectively, are agents who supported the negotiation of the payment rate and the payment schedule. The US Fish and Wildlife Service acted as a buyer representing the general public of the US to commence the PES scheme.

*Buyer type:*

The buyers can be divided into two main groups. The first group of buyers are the irrigation farmers of Los Negros (downstream) represented by the Municipality of Pampagrande who pay upstream landholders. If the payments are secured from general taxes the wider community of the Municipality of Pampagrande would be the buyers. Up until 2008, the downstream irrigators did not trust the upstream landholders to deliver the contracted management actions and protect the forest. That is, the irrigators were not convinced that they would receive what they paid for. As a result, only a few irrigators have engaged in voluntary contracts and have become 'direct' buyers.

The second group was the general public of the US represented by an international donor, the US Fish and Wildlife Service, a federal government agency within the US Department of the Interior, which made payments for the protection of cloud-forest habitat for migratory species to commence the PES scheme.

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[29] Native grassland in the Central Andes is called puna.

*Seller type:*

The ES sellers are landholders in the community of Santa Rosa de Lima (upstream). Only few of the landholders have a government-approved land title. Signed purchase contracts are used as proof of ownership, which is locally accepted.

*Seller selection:*

All landowners in the upper catchment have been offered to participate.

*Payment system:*

The scheme applies a uniform payment rate ($X per hectare of enrolled land per year) (P-I) that differs across forest types/ puna and their conservation values. The payment rate was initially negotiated between the environmental committees of Santa Rosa and Los Negros. If the negotiated payment rate for at least some of the sellers lies above their marginal costs per hectare of enrolled land more ES could have been bought for the same budget. In that case, the scheme's cost-effectiveness from the perspective of the buyers (community of the Municipality of Pampagrande and the general public of the US) or their agents (Municipality of Pampagrande and US Fish and Wildlife Service) could be improved. Of course, improving the cost-effectiveness of the scheme would reduce the net returns available to sellers.

*Seller performance measure:*

The PES scheme applies an input-based performance measure. The delivery of the ES (cloud-forest habitat protection and stabilization of dry-season water supply) is measured by contracted management actions (refraining from tree felling, hunting, and forest clearing on enrolled land).

*Type of returns received by seller:*

The buyers jointly compensate the sellers. Sellers receive direct returns in form of in-kind compensations equivalent to the negotiated payment rate. They can choose between beehives and apicultural training, barbed wire (used to strengthen land tenure claims against landless immigrants), and fruit tree seedlings. The majority of the sellers rejected

monetary payments. From their point of view, in-kind payments support saving and investment and have a lower perceived threat of land expropriation than monetary payments (Robertson et al. 2005). Sellers also receive indirect returns: a perceived increase in land tenure security (Robertson et al. 2005). An additional inventive for sellers to comply with their contract is the fact that forests are the preferred habitat of the honey bees. Hence their income from apiculture depends on continued forest protection (indirect returns).

*Conditionality:*

Payments are designed to be conditional on the fulfilment of contracted actions. A project control team conducts yearly monitoring. The team consists of a member of the upstream and downstream environmental committees, a representative of the Fundació Natura Bolivia, and the monitored landowner. Penalties for non-compliance are defined in the contracts (exclusion from the scheme for five years). The payments are made annually. The contracts (ranging from one to ten years) are renewable annually.

*Voluntariness:*

Seller participation is voluntary. Sellers choose the area(s) they want to enrol and the duration of the contract, ranging from one to ten years. The participation is voluntary for the downstream irrigator (potential buyers) but not for the community of Los Negros (represented by the Municipality of Pampagrande). The general public of the US (represented through the US Fish and Wildlife Service) did not have a choice.

*Additionality:*

Areas that are already conserved by the community are excluded from the PES scheme. Nevertheless, supplying additional ES has been one of the greatest challenges faced by this scheme for two main reasons. Firstly, the sellers mainly signed contracts for forest parcels that they would likely not have felled anyway (for instance, steeply sloped and inaccessible forest parcels that are low in agricultural productivity) but might clear forest elsewhere on their land ('on-farm leakage'). This suggests that the marginal costs per unit of input of the majority of forests that have been enrolled are probably (close to) zero. The possibility is that very little additional ES have been delivered as a direct outcome of

the PES scheme. Yet, payments in form of barbed wire have generated indirectly additional forest protection since land tenure claims from landless migrations have been controlled. Secondly, the cause-effect relationships between forest protection and the desired ES have been less than clear (e.g., the relationship between area of forest protected and quantity of water supplied). Even if landholders enrolled forest parcels they planned to clear, the magnitude of the additionally generated ES remains unknown.

*Transparency:*
The participants were actively involved in the design and implementation of the PES scheme through their representation in the upstream and downstream environmental committees. Of course, the level of transparency of the scheme depends on the level of transparency of the committees' engagement.

*Conclusion:*
This PES scheme is characterized by conditionality, voluntariness and transparency. The scheme's major challenge is securing additional ES supply as a direct outcome of the PES scheme. If very little additional ES supply has been generated, the scheme has mainly acted to redistribute wealth. Individual sellers, the upstream landholders, but not necessarily society as a whole, have been made better off. Furthermore, it remains unknown if the marginal costs of supply of any of the sellers are larger or smaller than the marginal benefits of the additionally generated ES. The scheme bears a risk of being economically inefficient in that it could make society worse-off.

## 5.4   EcoTender in Australia, Victoria:[30]

EcoTender, an ongoing initiative of the Victorian Department of Primary Industries (DPI), aims to supply decreased land salinity, water quality, water quantity, and biodiversity benefits.

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[30] The review of EcoTender is based on Eigenraam *et al.* (2005). The PES scheme may have been modified since 2005.

*Type and degree of agent intervention:*

The Victorian Government (represented by the DPI) initiated, designed, and implemented EcoTender. The Victorian Government acts as buyer representing the general public of Victoria. Funds to allow payments to be made are secured through tax payments.

*Buyer type:*

The Victorian Government is the sole buyer, representing the people of Victoria.

*Seller type:*

Sellers are multiple landholders/ agricultural producers located within North Central Victoria.

*Seller selection:*

In a first step, landholders register their interest. In a second step, DPI officials assess their land and decide whether they meet the basic eligibility criteria. Landholders who meet these criteria are then invited to submit a proposal to DPI specifying the actions they propose to perform and the payments they require as compensation. The actions are linked to ES supply through bio-physical models. Landholders are provided with information about actions that are available and the associated environmental scores. Proposals are ranked by the total score (EBI) and the required payments. Dividing the EBI by the required payment allows an estimation of marginal cost per unit of EBI: EBI/C. Proposals with the highest EBI per dollar are ranked and contracted until the budget is exhausted.

*Payment system:*

EcoTender uses an individualized P-$MC/I payment system. Individual marginal costs per unit of EBI are estimated through reverse auctions and an EBI scoring system. That is, the scheme recognizes that marginal costs per unit of EBI vary across potential sellers due to, for example, differences in skill level, local climate, or land productivity.

*Seller performance measure:*

Seller performance is assessed by input-based performance measures. The use of a bio-physical model (Catchment Modeling Framework) quantifies the link between contracted actions and supplied ES.

*Type of returns received by seller:*

Sellers receive direct returns as the payments received from the DPI. They may also enjoy indirect returns generated by the achieved environmental improvements on their properties. The reverse auction provides an incentive for suppliers to determine the required payments based on both their individual marginal costs of supply and their expected indirect returns.

*Conditionality:*

The buyer purchases actions performed by landholders. Two types of contracts are available: re-vegetation (5 year duration) and management of remnant native vegetation (10 year duration). Payments are made in instalments over the contract duration. Monitoring (self-reporting and monitoring by DPI officers) combined with penalties for non-compliance (cancelling of payments) ensures conditionality.

*Voluntariness:*

Participation is voluntary for suppliers. It is the landholder's choice whether or not to participate. Victorian tax payers – the buyers – have no choice.

*Additionality:*

The establishment of a baseline and the use of a bio-physical model (Catchment Modeling Framework) that quantifies the link between contracted actions and supplied ES ensure additionality of ES supply.

*Transparency:*

EcoTender is characterized by a high degree of transparency. All elements of the auction process including the ranking method and the scoring system are communicated to potential sellers. A spatial map showing potential scores is distributed to landholders, which allows them to choose the size and location of areas they want to be included to maximize their EBI.

*Conclusion:*

EcoTender is a transparent PES scheme that ensures additional ES supply through conditional payments to voluntary sellers. The use of bio-physical models ensures its effectiveness of the inputs in generating ES.

Since the scheme uses a individualized P-$MC/I payment system the net returns per unit of input are the same for all sellers even though the payment rate varies across sellers (assuming the reverse auction revealed the true marginal costs and assuming sellers accounted for any indirect returns in their proposals). The use of this payment system combined with a seller selection mechanism based on EBI/C makes this scheme cost-effective from the perspective of the buyers (general public of Victoria) or their agent (DPI). This implies that sellers could not extract any net returns. The distribution of net returns favours the buyers (general public of Victoria) or their agent (DPI).

Yet, the extent to which EcoTender has led to an improvement in social well-being cannot be determined since the marginal benefits generated by ES supply are not valued in monetary terms.

## 5.5   Payments for environmental services in north-eastern France[31]

The ongoing PES scheme initiated by the water bottling company Vittel (Nestlé Water) aims to maintain a low nitrate concentration in the aquifer to enable Vittel to comply with legislation defining 'natural mineral water' in its production. The ES bought are water filtration and maintenance of adequate levels of nitrate in the plant-root system leading to the desired nitrate concentration in the aquifer. Vittel has contracted farmers for 30 years to supply the ES.

*Type and degree of agent intervention:*
The PES scheme was initiated by Vittel (Nestlé Water). The payments were directly negotiated between each seller and the sole buyer Vittel. The agent, an institution created by Vittel (Nestlé Water), AGRIVAIR, was responsible for the development and implementation of the scheme through trust building, the provision of technical assistance and scientific inputs, encouragement of participation, design coordination, assistance in negotiations, and compliance monitoring.

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[31] [31] The review of the PES scheme in France is based on Perrot-Maître (2006). The PES scheme may have been modified since 2006.

*Buyer type:*

The sole buyer of these ES is Vittel (Nestlé Water), a private water bottling company in north-eastern France, whose business is at risk if nitrate concentrations rise above the legally determined level that allow the classification 'natural mineral water' for its product.

*Seller type:*

Sellers are private farmers impacting on the aquifer used by Vittel (Nestlé Water). Four groups of farmers were identified that differed by livelihood strategies, objectives, constraints and their willingness and capacity to participate.

*Seller selection:*

Since all farmers located within the spring catchment could have impacted substantially on the nitrate levels in the aquifer it was important to Vittel (Nestlé Water) that all farmers participated. Hence, sellers were selected based on the location of their farms.

*Payment system:*

A general payment package that specified the type of returns to sellers and the upper limits of the monetary payment rates were directly negotiated between all sellers and the sole buyer Vittel. The net returns to sellers range between the true marginal costs to sellers and the marginal benefits enjoyed by the buyer. All farmers located within the spring catchment could have impacted individually on nitrate levels. That is, all farmers included in the scheme had to be included to keep the nitrate levels at the desired level. This implies that limited competition across potential sellers gave each individual seller strong bargaining power. The strong bargaining power of the farmers most likely led to payments that are higher than the seller's marginal costs of supply.

Yet, the individuals' bargaining power varied with the percentage of land within the catchment owned by each potential seller and the distance of that land to the spring. As a result, the negotiated monetary payment rates, as part of the payment package, were negotiated between each seller and the buyer and thus vary across sellers. That is, the total payments vary across sellers.

*Seller performance measure:*

The seller performance is measured by input (adoption of new farming practices and technology that ensure low levels of nitrate) rather than output (nitrate and pesticide concentrations). A baseline was established and extensive hydro-geological modelling was conducted to establish a quantitative link between the ES provided and inputs at the sub-basin and plot level.

*Type of returns received by seller:*

Sellers have received direct returns in form of monetary and in-kind payments (free labour to compensate for more labour intensive farming practices; free technical assistance). The direct negotiations between each seller and the buyer provided an incentive for sellers to determine their required payments based on both their individual marginal costs and the expected indirect returns.

*Conditionality:*

The payments are conditional on the delivery of the contracted ES, assessed by an input-based performance measure and monitored by AGRIVAIR on a regular basis.

*Voluntariness:*

The Vittel PES scheme is characterised by a group of voluntary sellers and one voluntary buyer.

*Additionality:*

The ES supply is clearly additional.

*Transparency:*

Since participation in the scheme was voluntary for both the buyer and the sellers all steps in design and implementation (including the definition of changes in farming practices and technology as well as the price negotiations between the buyer and the sellers) were characterized by a high level of participation in the design of the scheme, which ensures its transparency. Yet, the information available does not specify if the sellers have information on the magnitude of each other's direct returns.

*Conclusion:*

This PES scheme is transparent and generates additional ES supply through conditional payments to voluntary sellers. It is highly effective in delivering additional ES. Direct negotiations between voluntary sellers and a voluntary buyer ensured that the both the buyer and the sellers are made better off. Hence, the scheme is economically efficient.

## 5.6   Payments for environmental services in China, Sichuan Province[32]

In 2009, the Government of the People's Republic of China initiated a new ecological restoration program as an extension of the existing Conversion of Cropland to Forest and Grassland Program (CCFGP). As part of that extension, a trial application of a modified PES scheme was established to examine if conducting a reverse auction combined with a B/C seller selection mechanism could improve the cost-effectiveness and economic efficiency of the existing CCFGP. The trial application aimed to encourage farmers to change their current land use as to support the improvement of water quality through a reduction of soil erosion, the enhancement of biodiversity conservation, and additional air purification.

*Type and degree of agent intervention:*

The Chinese Government, represented by the Sichuan Forestry Department, was the main agent. In its role as the sole buyer it represented the general public of China. That is, the payments to sellers were funded from public revenues.

*Buyer type:*

The buyers were the general public of China represented by the government.

*Seller type:*

The sellers were individual farmers from four sampled villages with land contracted from their village collectives.

*Seller selection:*

Sellers were selected through the application of Benefit-Cost Analysis. A reverse auction was used to estimate individual marginal costs of supply. It was characterized by a

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[32] The review of the PES scheme in China is based on Wang *et al.* (2012).

single-round and predetermined concealed budget limit. The actions that could be contracted were determined in advance and were outlined in an afforestation and management plan. Within these boundaries, farmers were free to choose a (bundle of) action(s) they wanted to perform. The proposals contained (a bundle of) action(s) as well as the payment required for compensation. Most farmers who participated were capable of developing their proposals without external assistance beyond the general information sessions. Only 28 per cent required additional support through technical staff. The bidding was conducted at the farm household level.

The individual proposals were ranked by B/C applying constant marginal benefits and using the required payments as an indicator for marginal costs of ES supply. The marginal benefits of individual proposals were estimated by the means of bio-economic models. The bio-economic models were informed by bio-physical models and the results of discrete choice experiments. The bio-physical models established a cause-effect relationship between actions and ES provision at the farm household level. The value the general public attached to the additional ES was estimated by surveying urban households using a discrete choice experiment. Hence, the bio-economic model allowed the estimation of the individual contribution of each farm household towards ES supply in monetary terms reflecting the generated marginal benefit. Proposals with a net benefit to society (B/C larger than one) were ranked and accepted until the budget limit had been reached. Proposals with a B/C smaller than one would have created a net loss to society and were not accepted even though the budget constraint would not have been exceeded.

*Payment system:*

The PES scheme used an individualized P-$MC/I payment system. Successful bidders received the total payments they put forward in their proposals. That is, the individualized payment rate equalled the individual marginal cost per total input incurred by each seller. Even though the payment rates varied across sellers, the net returns were the same for all sellers (ignoring any informational rents and indirect returns): zero. The results of a post-auction survey suggest that 82 per cent of respondents who compared their payments with other farmers acknowledged the differences in marginal costs of ES provision and thus did not object to the differences in payment rates.

*Seller performance measure:*

The performance of the ES sellers was assessed by input-based measures. The cause-effect relationship between land use changes (inputs) and the supplied ES (output) was established by a biophysical model (Li et al. 2010). The biophysical model allowed the quantification of the supplied ES per farmer and input used.

*Type of returns received by seller:*

Suppliers received direct returns in form of monetary and in-kind payments (grain and seedlings). The direct returns additionally included returns from local capacity building. Suppliers also enjoyed indirect returns associated with the achieved environmental improvements on their properties and with future harvesting of the products from the trees planted. The reverse auction provided an incentive to suppliers to determine the required payments based on both their individual marginal costs and the indirect returns they expected.

*Conditionality:*

The payments were conditional on fulfilment of individual contracts relating to inputs. The contract duration was three years. The payments were made in three instalments. The first payment was made directly after signing the contract, the second and third was conditional on contract compliance. Monitoring was conducted by local forest bureaus facilitated by the Sichuan Forestry Department.

*Voluntariness:*

The results of a post-auction survey suggest that 97 per cent of the farmers participated on a voluntary basis. Three precent stated they were asked by their village head to participate.

*Additionality:*

The application of a bio-physical-model that set a baseline and established the link between actions and ES provision enabled estimating the additional ES that were supplied. The PES scheme generated additional ES supply.

*Transparency:*

Information sessions before the reverse auctions were conducted for potential sellers. During these sessions, the characteristics of the reverse auction as well as information

about the contract design were communicated to potential sellers. Monitoring and enforcement were transparent.

*Conclusion:*

This PES scheme was transparent and generated additional ES through conditional payments to voluntary sellers. The use of reverse auctions to estimate individual marginal costs and the application of a B/C ranking of proposals increased the cost-effectiveness from the perspective of the buyers (general public of China) or their agent (Sichuan Forestry Department) by 15 per cent compared to the original CCFGP. This increase in cost-effectiveness was measured as a decrease in government spending for an equal quantity of afforestation and other management activities. The transaction costs of neither the original CCFGP nor the trial scheme were included in this calculation. Of course, the improvement in cost-effectiveness reduced the net returns available to the sellers. The scheme distributed the net returns in favor of the buyers (general public of China) or their agents (Sichuan Forestry Department).

The transaction costs of the scheme were a third higher than those of the original CCFGP. Yet, the fixed costs in establishing a reverse auction (e.g., costs of research and skill development) are expected to diminish if applied on a wider scale (Gole et al. 2005). Hence, economies of scale are anticipated to decrease the transaction costs of reverse auctions significantly. The use of reverse auctions was feasible even though the skill and education level of the potential sellers was low. The application of an individualized P-$MC-I payment system did not lead to significant social tensions. The use of a B/C selection mechanism increased the effectiveness of the scheme and ensured that improvements in social well-being were achieved.

## 6.    Conclusion

Numerous PES schemes have been implemented around the world over the last decades. They provide some evidence that linking exiting demand with potential supply can be successful if the transaction costs of a PES exchange are lowered through agent intervention that is customized to the specific conditions of the PES scheme location.

This report has discussed a range of characteristics that impact on a PES scheme's potential to be effective in delivering ES and to ensure an improvement in economic efficiency in that it makes society better-off. Each PES scheme discussed in this report varies to some degree in the mix of its characteristics. Consequently, the level of effectiveness and economic efficiency, as well as the distribution of net returns between sellers and buyers (or their agents) vary significantly across these schemes.

The choice of a seller selection mechanism and a payment system, together with a scheme's degree of transparency, additionality, conditionality, and voluntariness, significantly affects a PES scheme's effectiveness, economic efficiency and net return distribution.

A PES scheme that selects sellers based on a ranking of proposals using BCA principles enables the selection of the highest net benefit providers and allows the exclusion of proposals that would result in a net loss to society. The application of BCA principles requires information on generated individual marginal benefits and individual marginal costs of supply that can be obtained through bio-economic models, economic valuation, and reverse auctions. The application of BCA principles ensures that PES schemes are economically efficient in that they make society better-off.

The choice of the payment system largely determines how the net returns (ignoring any indirect returns) are distributed between individual sellers. A concern advanced regarding the choice of the payment system is perceived fairness and equity. Specifically, not paying the same payment rate to all suppliers may lead to social conflict and/ or the rejection of the PES scheme.

Payment systems that apply payment rates based on individual marginal costs result in equal distributions of net returns for the same quantity of inputs or outputs to sellers even

though the payment rates differ across individual sellers (ignoring any informational rents and indirect returns). By contrast, PES schemes that apply uniform payment rates or those that apply payment rates equal to marginal benefits enjoyed by the buyers, lead to unequal distributions of net returns for the same quantities of inputs or outputs across sellers.

The choice of the payment system also affects how the net returns (ignoring any indirect returns) are distributed between sellers and buyers (or their agents). The use of payment systems that apply payment rates based on individual marginal costs have the potential to improve the cost-effectiveness of a PES scheme from the perspective of the buyers (or their agents). Reduced public spending in achieving ES supply goals increases the overall resources available to supply ES or other targets of government expenditure (e.g., education, health) elsewhere. Of course, cost-effective PES schemes deny sellers the opportunity to secure any net returns (ignoring any indirect returns) as happens in traditional competitive markets. Payment systems that allow (some) sellers to secure net returns include those that apply uniform payment rates and those that apply payment rates based on the marginal benefits enjoyed by the buyers.

Payment systems that apply payment rates equal to the marginal costs of the highest cost (but still socially efficient) provider allows sellers to extract the type of net returns that are enjoyed by sellers in competitive markets. Of course, allowing sellers to extract individual net returns reduces the overall resources available to supply ES elsewhere. Yet, such payment systems provide an opportunity for both sellers and buyers (or their agents) to extract net returns - the net returns are shared. The magnitude of the net returns received by sellers and buyer (or their agents), respectively, depends on the price elasticity of demand and supply. In the extreme case of a perfectly elastic (inelastic) demand, all net returns would be earned by the sellers (buyers or their agents).

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