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Determining when payments are an effective policy approach to ecosystem service provision

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ABSTRACT

There are several policy tools available for the provision of ecosystem services. The economic characteristics of the ecosystem service being provided, such as rivalry and excludability, along with the spatial scale at which benefits accrue can help determine the appropriate policy approach. In this paper we provide a brief introduction to ecosystem services and discuss the policy tools available for providing them along with the dimensions, political feasibility and appropriateness of each tool. Throughout the paper we focus primarily on payments as a mechanism for ecosystem service provision. We present a framework for determining the characteristics of an ecosystem service and when payments are a viable policy tool option based on the characteristics. Additionally, we provide examples of when payments do not provide a socially desirable level of ecosystem benefits. We conclude with a summary of policy recommendations, specifically desirable property rights and payment types based on the particular classification of an ecosystem service. We also discuss the advantages of creating monopsony power to reduce transaction costs, delineating and bundling ecosystem services and utilizing existing intermediaries.

1. Overview

Payments for ecosystem services (PES) have become an increasingly popular approach to dealing with environmental problems around the world. Hundreds of payment agreements have been arranged in both developing and developed nations. Several case studies have been written about their successes, failures, limitations and challenges of implementation (Pagiola et al, 2002). There has been little discussion, however, about how to design a payment program based on the spatial distribution and the economic characteristics, such as rivalry and excludability, of the service being provided. These characteristics influence the number and geographic distribution of the benefits and costs of the service, the feasibility of collective action and the level of transaction costs associated with providing the service (Daly and Farley, 2004; Hein et al., 2006; Turner et al., 2003; Ostrom, 2003). This paper offers a framework for identifying the appropriate policy tools and the necessary conditions for the design of a viable payment program based on a synthesis of existing theory, case studies and empirical findings.

We first provide a brief introduction to ecosystem services. We then discuss the policy tools available for providing them along with the dimensions, political feasibility and appropriateness of each tool. Throughout the paper we focus primarily on payments as a mechanism for ecosystem service provision. We present a framework for determining when payments are a viable policy tool option based on the characteristics of the ecosystem service. Additionally, we provide examples of when payments do not provide a socially efficient level of ecosystem benefits. Finally, we conclude with a summary of policy recommendations, specifically desirable property rights and payment types based on the particular classification of an ecosystem service. We also discuss the advantages of creating monopsony power to reduce transaction costs, delineating and bundling ecosystem services and utilizing existing intermediaries.

2. Introduction to ecosystem services

Ecosystems provide services essential to human survival and well-being. For example, forests supply climate regulation, erosion control and aesthetic beauty; wetlands offer protection from storms and floods; and grasslands supply habitat and genetic resources (Millennium Ecosystem Assessment, MEA, 2005; Costanza et al., 1997; Daily, 1997). Yet most ecosystem services are external to the market system. Not only are these services neglected, current economic incentives encourage rapid degradation of the natural capital, such as forests and wetlands, that provide the services. Natural capital plays dual roles. It can be converted into raw material inputs essential to all economic production, or it can be left intact to provide critical ecosystem services. As most economic output is in the form of market goods and

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most ecosystem services are non-market goods, the market system systematically favors conversion over conservation. In addition, natural capital provides ecosystem services at a given rate over time, over which humans have very little control. In contrast, we can decide how rapidly to convert natural capital to economic output. Therefore, short time horizons also favor conversion over conservation. Most economists and policy makers recognize that it is the responsibility of the government, with support from the civil sector, to provide goods and services that are external to the market (Daly and Farley, 2004). Although many ecosystem services are public goods, the physical structure that provides them is often privately-owned. Policies are needed to encourage private landowners to provide ecosystem services.

3. Policy tools for ecosystem service provision

Governments have a variety of policy tools at their disposal to encourage landowners to internalize the benefits provided by the natural capital on their property. Policy tools are methods employed to form collective action in order to provide a public good (Salamon, 2002). Salzman identifies five types of tools—prescription, penalty, property rights, persuasion and payment (Salzman, 2005). Policy tool choice for ecosystem service provision should depend on the dimensions of the tool, that is, the extent to which the policy is viable in a particular context and effective in achieving a particular level of ecosystem service provision. Policy tool choice should also depend on the characteristics of the ecosystem service being provided such as spatial scale and whether it is a market good or service, public good, common pool resource or a club good.

Policy tools exhibit varying levels of coerciveness, visibility, directness and automaticity (see Table 1) (Salamon, 2002). Salamon defines coercion as the extent to which a tool restricts behavior as opposed to merely encouraging or discouraging it. Coercive policies usually have a low level of political support (Salamon, 2002, p 26). Because many ecosystem services are provided by privately-owned natural capital, coercive policies may be politically difficult to implement and may only be necessary under circumstances in which an entire ecosystem is threatened and immediate action is required. However, policy tools that exhibit high levels of visibility, that is, the costs and benefits of the policy are easily detected by both the providers and beneficiaries, may be more politically feasible. Direct policies are those for which the authorizing, financing or inaugurating entity is highly involved in the delivery of the service. Automaticity is the extent to which existing institutional structures are used to carry out a program. A policy tool with a high level of automaticity usually has lower transaction and implementation costs.

Table 1
Policy tools and degree of each dimension.

Policy tool/dimension	Coerciveness	Visibility	Automaticity	Directness
Prescription				
Regulation[1]	High	Low	Low	Medium
Penalty				
Taxes[2]	Medium	Medium	High	Medium
Property rights				
Land use moratorium[3]	High	Low	Low	High
Tradable permits[2]	Medium	Medium	Medium	Medium
Payments				
Tax	Low	Medium	High	Medium
Expenditures[4]	Medium	High	High	Low
Grants[5]	Low	Medium	Low	Medium
Easements[3]	Low	High	Low	High
Direct payments[3]				
Public information[6]	Low	Medium	Low	Low to High

Note: From (Salamon, 2002) [1]Peter J. May; [2]Joseph C. Cordes; [3]Authors' classification; [4]Christopher Howard; [5]David R. Beam and Timothy J. Conlan; [6]Janet A. Weiss.

Table 1 delineates the dimensions of policy tools available for ecosystem service provision. For example, tax expenditures exhibit low levels of coerciveness because exemptions, deductions or tax credits are rewarded for voluntary behavior or participation in a program. Tradable permits are moderately automatic because institutions that facilitate trading need to be established but once the system is set up it creates automatic incentives for participating. Because costs and benefits of land use moratoria are not easily observable or measurable, they are classified as having a low level of visibility.

All five policy tool types are mechanisms available for providing ecosystem services on private property. Whether a policy tool is efficient, equitable, effective, manageable or politically feasible depends on its dimension classification (Salamon, 2002). These evaluation criteria vary in importance depending on public goals. If an ecosystem is highly threatened and deemed a priority area, effectiveness may be a higher priority than efficiency or political feasibility. In contrast, if the marginal cost of damage is low, efficiency and equity may be a higher priority.

Policy tools that are effective and politically feasible for encouraging industry to limit demand for ecosystem services may not be viable for reducing demand and increasing supply by private landowners due to differences in property rights. Typically, the government curbs emissions through policy tools such as taxation and regulation. When industry pollutes the atmosphere, for example, it is executing a privilege, not a property right — industry does not "own" the waste absorption capacity that reduces pollution. The government can revoke this privilege and claim waste absorption capacity for the public, essentially establishing public property rights, by instituting a "polluter pays" principle or by regulating the amount of emissions allowed (Bromley, 1993). However, a landowner is not obligated to relinquish ownership of trees on his property to provide climate regulation in the same way an industry polluter can be coerced to reduce pollution to provide clean air. In fact, they frequently have the explicit right to fell the trees and sell the timber for profit.

Prescriptive policies for the provision of ecosystem services on private property such as regulating land use or development are highly coercive and usually require extensive management and oversight. Automaticity is low making them politically infeasible and costly to implement. Coercive policies, however, are highly effective when enforced and may be necessary when marginal damage to an ecosystem is high.

Penalties, or taxes and charges, are highly automatic and are an efficient mechanism for eliciting land management practices that provide ecosystem services. However, they may not be viewed as equitable because the landowner would essentially be required to pay for the provision of ecosystem services for the benefit of the entire public. Taxes are also moderately coercive and therefore elicit only moderate political support. Cap-and-trade policies, or tradable permits, essentially establish property rights for the public for an ecosystem service and allow suppliers to buy and trade the right to use it. Permits are moderately coercive and entail higher initial transaction costs than other policy tool options because they require a trading system to be established.

The alteration of property rights, such as a moratorium on land use, is highly coercive and usually politically infeasible. Like regulation, it is highly effective and is only necessary when an ecosystem is classified as a high priority area. For example, in 2002 the U.S. Supreme Court upheld a moratorium on development, without compensation to landowners, by the Tahoe Regional Planning Agency that was instituted to protect the pristine beauty of the Lake Tahoe basin (Turnbull, 2004). Prescription and penalty are, in effect, revocations of property rights because they require that a landowner relinquish or alter land practices or development without compensation.

In contrast to altering property rights, disbursing public information about ecosystem services in an effort to change landowner

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behavior has a very low level of coerciveness. As a policy approach it can achieve a high level of political support and because information campaigns can directly target potential providers of ecosystem services, it can be highly effective. However, in situations where opportunity costs are high and implementation efforts are also costly, information alone may not be enough to induce changes in behavior.

Payments for ecosystem services (PES) have been defined as voluntary transactions where an ecosystem service is being bought by one or more buyers from one or more providers, if and only if a provider secures the provision of the service (Wunder, 2005). If a payment option is present, either as a tax expenditure, grant allocation, easement or direct payment, landowners can voluntarily supply ecosystem services on their property and be compensated for providing the service. This low level of coercion makes payments a politically feasible option for supplying the privately-owned physical structure that provides ecosystem services. Tax expenditures and grants are highly automatic however, easements and direct payments often require creation of institutions and financing mechanisms and can be costly to implement. Payments are an efficient mechanism for providing ecosystem services when these transaction and implementation costs are low and benefits can be captured by the payees.

A wide variety of payment programs have been implemented to provide ecosystem services across the globe. Examples include national-scale programs in Costa Rica and Mexico, decentralized approaches in Ecuador and Indonesia, agri-environmental programs in the United States and Europe and conservation concessions and easements (Engel et al., 2008). In Ecuador a watershed conservation program in Cuenca and Quito provides clean drinking water and a Forests Absorbing Carbon-dioxide Emissions Forestation Program has established carbon fixing plantations in the highland region (Wunder and Albán, 2008). In South Africa a PES program has emerged for hydrological services in which water utilities and municipalities contract a government-funded program that employs previous jobless individuals. The program simultaneously restores riparian zones and addresses local poverty issues (Turpie et al., 2008). Forty six farmers are paid in-kind to protect a watershed in Bolivia's Los Negros Valley. This program bundles services such as habitat protection and hydrological flow to induce a variety of beneficiaries, including the US Fish and Wildlife Service and the Los Negros municipal government on behalf of local irrigators, to participate (Asquith et al., 2008).

4. Monopsony and monopoly power

Reducing the cost of PES programs is achieved through creating a monopsony, a single buyer, and reducing monopoly power in the payment arrangement. A monopoly exists when a single potential provider has inordinate bargaining power and can drive up the price of a service. The institutions needed to create a monopsony and to effectively capture the benefits depends on the spatial distribution and the characteristics of the ecosystem service being provided. When an individual or entity has monopsony power because they are the sole beneficiary and potential buyer of a service, their willingness to pay can be easily calculated based on the value of the service to their well-being or operation. If monopsony power exists, the free-rider problem associated with public goods is avoided. A sole beneficiary knows they will capture all of the benefits of the ecosystem service they are paying for. For example, a hydroelectric power (HEP) company may pay upstream landowners to manage their property to reduce siltation downstream. Monopsony power in a payment program is preferred because it reduces transaction costs. No coordination or agreement amongst buyers is required. If a monopsony exists or can be created, basic Coasian rules apply, that is, because transaction costs are low, bargaining between the buyers and sellers of ecosystem services will lead to an efficient outcome regardless of initial property rights. Transaction costs for PES typically include: the technical work required to establish linkages between the ecosystem structure and the services it provides; the creation of organizations to manage, monitor and support a program; putting in place strong legal institutions to enforce property rights; and the on-going operating costs of monitoring and renegotiating contracts (Pagiola et al., 2002). The costs of seeking out buyers and sellers, forming negotiations and agreements, and certifying deals also accrue at the inception of a payment program (Grieg-Gran and Bann, 2003). Reducing transaction costs has been identified as one of the leverage points for motivating growth in payments for ecosystem services programs (Pagiola et al., 2002).

If a monopsony does not exist, it can be created through institutions. For example, New York City relies on the filtering services of natural ecosystems to maintain high water quality in its reservoirs. However, poor agricultural practices were compromising the clean water (Daily and Ellison, 2002). The City compared the costs and benefits of installing a filtration plant to the costs and benefits of implementing best management practices in the watershed and determined that paying farmers to better manage their land would result in the same benefits at a lower cost. Additional fees on consumers' water bills serve as the collection mechanism. The New York City Water Authority acts as a monopsony representing the City's water users. A monopsony should be created at the scale at which the benefits of the ecosystem service accrue.

In contrast, monopoly power in the market has disadvantages. A service provider with monopoly power can potentially drive up the asking price, especially if the provider has little financial incentive to participate, the service provided is scarce, or because there is no pressure from partnering service providers to come to an agreement. Monopsony power does not skew a market for ecosystem services because although there is only one buyer available to purchase the ecosystem service, the seller is not forced to sell to that buyer because they have the option to use their property for the next best alternative such as agriculture, harvesting timber or development. Alternatively, if there is only one service provider, such as a single landowner upstream, downstream buyers have no other option but to purchase the desired ecosystem service from the upstream landowner giving the provider extreme bargaining power. This problem becomes even more acute when demand for a service becomes inelastic due to the essential and non-substitutable nature of an ecosystem service. In addition, if an ecosystem threshold effect exists, such as when a species requires a minimum level of habitat, each potential ecosystem service provider holds monopoly power. If monopoly power exists for an ecosystem service, an alternative policy tool such as prescription, penalty, property rights or public information should be considered.

In addition to inducing land management practices that provide ecosystem services, policy tools are required for the collection of funds for PES programs. Taxes, fees and voluntary contributions are mechanisms that are often employed to collect funds from beneficiaries that are then distributed to the providers of ecosystem services. Cap and auction systems are a form of PES that can also provide funding for other PES programs. Commercial consumers of ecosystem services are sometimes required to offset their use by paying private landowners to supply additional ecosystem services. In Costa Rica, for example, program financing comes from several sources: a national fuel tax on crude oil derivatives, differentiated entrance fee schedules in national parks, voluntary contributions in the private sector such as payments by hydroelectric companies, Norwegian and Dutch governments through the UNFCC Clean Development Mechanism, and a World Bank grant and credit line (Pagiola et al, 2002). In some cases payments are the most politically feasible, effective and efficient policy tool available for inducing a private landowner to manage their property for ecosystem services. They are effective when both the marginal cost of damage to the ecosystem and the opportunity cost of provision are low. However, payments are not efficient for ecosystem services exhibiting particular characteristics. If payments are appropriate, a monopsony should be developed through institutions at the scale of the benefits of the ecosystem service.

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5. Characteristics of ecosystem services

Ecosystem services exhibit characteristics that determine whether or not payments are a viable tool for providing them. The combination of rivalry and excludability tells us what type of good the ecosystem service is and whether payments will induce a socially desirable level of provision.

5.1. Rivalry

Rivalry is an innate property that cannot be altered by policy or legal institutions. If a good or service is purely non-rival, the use of that good or service by an individual does not have a significant impact on the quality or quantity available to others (Daly and Farley, 2004; Randall, 1993; Samuelson, 1954). One person benefiting from the protection of the ozone layer does not affect the quality or quantity of protection for another. However, the quality of some non-rival goods and services can be affected by the number of people using the good or service at one time. These goods and services are considered to be congestible (Daly and Farley, 2004; Randall, 1993). For example, a hiker's experience in a state park would probably not be altered if one other person was in the park. Yet, if there were several thousand people in the park, the quality of his experience would likely be diminished. A purely rival good or service, on the other hand, is one in which its use or consumption by an individual precludes use or consumption by another (Daly and Farley, 2004). Commonly purchased goods or services, such as a t-shirt, an orange, or a haircut, fall under this category. Finally, an anti-rival good is one which is enhanced with use by multiple people. Information and some technologies are anti-rival goods. For example, the more people who take a remedy for a contagious disease or use an effective pollution control device, the better off we all are. The marginal value of a rival good is the maximum amount an individual is willing to pay, while the marginal value of a non-rival good is the sum of the willingness to pay of all individuals. The marginal cost of use for a non-rival ecosystem service is zero so a one-time payment by a monopsonist, with zero payments for use, is the most efficient method for providing a non-rival service.

5.2. Excludability

If an ecosystem service is excludable, technology or institutions exist that make it possible to prevent others from using the good or service: unlike rivalry, it is created through policy and institutions. No good or service is inherently excludable, although most rival goods can be made excludable through institutions. For example, a pair of jeans is certainly rival, but without property rights and enforceable laws, there would be nothing preventing an individual from walking into a department store and claiming a pair. There is nothing intrinsically excludable about a pair of jeans. However, a good or service can be inherently non-excludable. An ecosystem service is non-excludable when it is impossible to create property rights or the costs of enforcement are too high. It would be virtually impossible, for example, to exclude someone from the benefits of climate regulation (Daly and Farley, 2004). A good or service is also non-excludable when the technology or institutions exist to exclude use but property rights are not enforced. An ecosystem service falls loosely into one of seven categories depending on its combination of rivalry and excludability (see Table 2). The categorization of an ecosystem service determines whether a payment policy would be an effective mechanism for its provision.

5.3. Spatial distribution

Understanding the spatial distribution of ecosystem services is key to identifying potential beneficiaries, the institutions required to provide the service and the transaction costs associated with provision. Spatial distribution can be characterized by the directional flow of the service and its scale, that is, the geographic extent to which benefits accrue (Costanza, 2006). Climate regulation, for example, is an omni-directional service that accrues at the global scale. Water services, in contrast, are directional flow related and benefits accrue downstream at a regional, watershed scale. Biodiversity services, such as wildlife habitat occur in situ, but have local, regional and global benefits. In general, the more global the service, the higher the transaction costs. Because everyone benefits from global services, there is not a well-defined group of buyers, which causes negotiations and agreements to be costly (Salzman, 2005). Homogenous services that disperse evenly in all directions such as climate regulation that also have a high degree of spatial mobility tend to have higher transaction costs than more spatially bound services such as water regulation and supply where the beneficiaries are usually located within a definable area (Wunder, 2005). A monopsony should be created at the scale at which the benefits of the ecosystem service accrue in order to reduce transaction costs and to exclude those who do not pay for the service.

6. Ecosystem service classification

We know that forming a monopsony is an effective and efficient means of providing ecosystem services and that the combination of rivalry, excludability and spatial distribution determines how and at what scale a monopsony should be formed. Following are recommendations for ecosystem service provision for each classification category.

Pure public goods, such as biodiversity and climate regulation, are non-rival and inherently non-excludable. It is impossible to exclude anyone from benefiting from the existence of a species nor does one person's enjoyment of its existence diminish or preclude enjoyment by others. The same is true for climate regulation. In addition, the existence value of biodiversity and climate regulation both span global scales and are omni-directional. Because benefits are diffuse, there are many potential buyers for global public goods. Therefore, a global institution is required to act as a monopsony on behalf of global

Table 2
Combination of rivalry and excludability.
Adapted from Randall (1993).

	Non-excludable	Excludable
Non-rival	Pure public good *Biodiversity, climate regulation*	Inefficient market good
Congestible	Congestible public good *Free public beaches, public parks*	Toll or club good *Private beaches, game reserves, private eco-tourism sites*
Rival	Common pool resource *Ocean fisheries*	Market good *Food, raw materials*
Anti-rival	Public good *Genetic information available for public use*	Inefficient market good *Genetic information protected by convention on biodiversity*

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beneficiaries to reduce both transaction costs and free-riding behavior. The marginal cost of use for a non-rival ecosystem service is zero, therefore a one-time payment is most efficient if on-going management costs are minimal (Table 3). For example, Costa Rica secures funds from the Global Environmental Facility (GEF), which represents global beneficiaries, to reforest for carbon sequestration and to protect habitat for biodiversity benefiting those who value the existence of species.

Market goods, such as raw materials and most food products, are rival with strong, enforceable property rights. Payments are an appropriate mechanism for providing ecosystem services that exhibit the characteristics of a market good. No matter the scale of the benefits, if a beneficiary pays for an ecosystem service exhibiting the properties of a market good, they will capture all of the benefits of the service. A Coasian solution can emerge because bargaining is possible and transaction costs are low. Payments in this case are efficient—if there are no negative externalities—effective and politically feasible. Furthermore, if a monopsony exists for a market good, transaction costs will be even lower. For example, in Costa Rica, Energía Global, a private hydroelectric power provider, pays $10/ha/year for reforestation and forest management upstream to maintain smooth streamflow. It was determined that output and revenue are maximized through water regulation so the company would benefit from its investment in reforestation (Chomitz et al., 1999). Energía Global's monopsony power reduced the transaction costs of establishing the payment system.

A common pool resource is a good or service that is rival but for which it is difficult to enforce property rights that exclude use such as ocean fisheries and waste absorption capacity. Because it is difficult to exclude use, common pool resources are often overused if unmanaged (Hardin, 1968). Payments are not an effective policy tool for common pool resources. However, property rights can be created through permits implemented at the scale at which the benefits accrue. A variety of institutions can organize the beneficiaries of common pool resources and act as a monopsony. The Clean Development Mechanism established by the United Nations Framework Convention on Climate Change (UNFCCC) is the mode of distribution for the Kyoto Protocol, an international cap-and-trade program for waste absorption capacity which is a global common pool resource. Permits can also be developed for ocean fisheries. They limit access to the resource and allocate property rights. Often a market is established for trading permits.

Toll or club goods, such as recreational services, are those that are non-rival but congestible and excludable. These ecosystem services are usually local or regional and spatially bound and therefore easily excludable if property rights are enforced. Because they are excludable, payments are an effective policy tool for providing them. As with public goods which are also non-rival, the marginal cost of use for a toll good is zero. Therefore, a one-time payment is most efficient. Ecosystem services that exhibit the characteristics of a toll good can be provided by the public, private or civil sector through entrance fees.

When an ecosystem service is anti-rival but excludable, it is an inefficient market good. Payments are an inefficient policy approach when an ecosystem service is anti-rival. Because benefits increase through use, exclusion through property rights in effect creates a monopoly for the service and results in a socially inefficient level of provision. Through the Convention on Biological Diversity (CBD) many developing countries, which house most of the world's genetic resources, have implemented laws and policies that regulate access to resources and require benefit sharing with scientists such as royalties and technology (Ten Kate, 2002). The CBD defines “genetic resources” as any material of plant, animal, microbial, or other origin containing functional units of heredity of actual or potential value. These barriers to obtaining access have directed research and development toward the use of existing collections of genetic resources rather than encouraging new discoveries which could contribute to the global public good (Ten Kate, 2002). Privatization and property rights limit access. For a socially optimal level of discovery and use, inefficient market goods should be managed as public goods. Institutions that represent the population of beneficiaries should act as a monopsony to purchase the provision of ecosystem services that are anti-rival and excludable.

Table 3
Recommended policy approaches.

	Recommended policy approach
Public good	One-time payment by institution acting as monopsony
Market good	Individual payments
Common pool resource	Make excludable through property rights; tradable permits
Toll or club good	Treat as public good; when becomes congestible require one-time payment by individuals
Inefficient market good	Treat as public good; provide incentives for use

7. Summary of recommendations

In summary, payments are a desirable policy tool for encouraging private landowners to manage their land for ecosystem services. However, ecosystem services exhibit characteristics that determine whether payments are an appropriate policy tool. Additionally, the creation of a monopsony within a payment program will reduce transaction costs. When designing a payment program to induce ecosystem service provision, a policymaker should first determine whether the ecosystem service is a public good, market good, toll good, common pool resource or inefficient market good. Next, she should identify the spatial scale at which the benefits accrue. These classifications will help determine if payments will be efficient, effective and politically feasible and what institutions are required to create monopsony power.

The following recommendations will also help build political support for PES initiatives and increase their sustainability. It is important to identify multiple funding sources and to increase automaticity of policy implementation by utilizing existing intermediaries.

7.1. Delineating and bundling services

In many cases, buyers of ecosystem services are interested in purchasing a single, definable service. However, because it is difficult to delineate services within complex ecosystems, payment programs almost always bundle services. If policymakers can identify multiple funding sources for a bundle of services, they will be investing in an insurance policy that will support the program if one facet or funding source is less sustainable than the others. Bundling of services is a holistic approach that ultimately increases benefits. In a bundled approach, the focus is on providing multiple ecosystem services. The services are either sold together or subdivided and marketed to different buyers. Bundling services that have benefits across spatial scales is a way to expand the potential market and increase payments to a particular area. Bundling services is advantageous, however, accruing multiple benefits across scales and political boundaries does increase transaction costs when each service has a different spatial distribution and therefore different beneficiaries.

For instance, Costa Rica's National Forestry Environmental Service's Program bundles the provisioning of carbon sequestration, watershed protection, biodiversity conservation, and scenic beauty services, and markets them to different buyers (Rojas and Aylward, 2003). Bundling services can increase political support for a payment scheme by increasing the beneficiaries of the program. In Sukhomajri, India, a payment scheme originally geared toward reducing siltation in Sukna Lake for recreational benefits was able to gain needed support by provisioning irrigation benefits to upland villagers (Pagiola

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et al., 2002). Bundling ecosystem services also eliminates the potential for the provision of one service to crowd out another. For example, in some cases plantations of non-native tree species provide carbon sequestration at the expense of biodiversity.

7.2. Provisioning locally valuable services

A lasting, positive change will take place if PES programs catalyze sustainable practices desired by those providing the services. For example, the suite of best management practices initiated in the NYC Watershed will ultimately aid farm profitability by maintaining soil nutrients on site (Daily, 1997). In Sukhomarjri, the benefits provided to upland villagers are as important as those provided to residents of Chandigarh who utilize Sukna Lake (Pagiola et al., 2002). And in a reforestation scheme proposed for Awassa, a region in Ethiopia, reforested areas would eventually supply firewood, restore trees through sustainable practices, as well as improve grazing productivity by increasing the water holding capacity of the land (Reynolds et al., in press).

7.3. Pooling supply and demand

Transaction and implementation costs can be minimized by developing a system for pooling funds from groups of buyers which, in effect, creates a monopsony situation. Costs are further reduced when providers are organized cooperatively. In Brazil, local governments served as a collective entity receiving ICMS Ecológico tax revenue. And in Chiapas, coffee growers were able to reduce the costs of implementation through a cooperative certification program (Pagiola et al, 2002). In addition, regional cooperation and the pooling of supply can help avoid the wielding of monopoly power by any single supplier when threshold effects exist.

7.4. Utilizing existing intermediaries

Costs are also minimized when skilled intermediaries are already in place. In Costa Rica, the preexisting National Forestry Finance Fund served effectively as an intermediary. In New York, the NYC Department of Environmental Protection had sufficient expertise to direct user fees to conservation programs. Where government institutions are insufficient, preexisting nonprofit organizations can serve an intermediary role, as is the case in Chiapas, Mexico. Automaticity of payments is another way to reduce transaction costs (Stone, 2002). This occurs, for example, when buyers of an ecosystem service are already organized as a group of consumers for a water utility and can make a payment through an additional fee on their bill (Pagiola et al., 2002; WWF, 2006).

8. Conclusion

Payments are an important mechanism for sustaining the natural capital that provides ecosystem services upon which our well-being and livelihoods depend. Payment programs draw on a multitude of approaches and implicate a variety of individuals and institutions. There is no one-size-fits-all arrangement for the successful implementation of a PES program. However, we can utilize our knowledge of basic economic principles and policy evaluation criteria to guide program design.

References

Asquith, N.M., Vargas, M.T., Wunder, S., 2008. Selling two environmental services: in-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. Ecological Economics 65, 675–684.

Bromley, D.W., 1993. Regulatory takings: coherent concept of logical contradiction? Vermont Law Review 17 (3), 647–682.

Chomitz, K.M., Brenes, E., Constantino, L., 1999. Financing environmental services: the Costa Rican experience and its implications. The Science of the Total Environment 240, 157–169.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260.

Costanza, R., 2006. Presentation Given at the Ecosystem Services Conference. University of Vermont, Burlington, VT.

Daily, G.C., 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC.

Daily, G.C., Ellison, K., 2002. The New Economy of Nature: The Quest to Make Conservation Profitable. Island Press, Washington DC.

Daly, H., Farley, J., 2004. Ecological Economics: Principles and Applications. Island Press, Washington, DC.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecological Economics 65, 663–674.

Grieg-Gran, M., Bann, C., 2003. A Closer Look at Payments and Markets for Environmental Services. WWF Macroeconomics for Sustainable Development Programme Office.

Hardin, G., 1968. The tragedy of the commons. Science 162.

Hein, L., van Koppen, K., de Groot, R.S., van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. Ecological Economics 57 (2), 209–228.

Millennium Ecosystem Assessment (MEA), 2005. Ecosystems and Human Well-being: Policy Responses: Findings of the Responses Working Group of the Millennium Ecosystem Assessment. Island Press, Washington (D.C.).

Ostrom, E., 2003. How types of goods and property rights jointly affect collective action. Journal of Theoretical Politics 15 (3), 239–270.

Pagiola, S., Bishop, J., Landell-Mills, N., 2002. Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development. James & James/Earthscan, London.

Randall, A., 1993. The problem of market failure, In: Dorfman, R., Dorfman, N. (Eds.), Economics of the Environment, 3rd ed. Norton, New York, pp. 144–161.

Reynolds, T.W., Farley, J., Huber, C., in press. Investing in human and natural capital: an alternative paradigm for sustainable development in Awassa, Ethiopia. Ecological Economics.

Rojas, M., Aylward, B., 2003. What are we learning from experiences with markets for environmental services in Costa Rica? A Review and Critique of the Literature, International Institute for Environment and Development, London.

Salamon, L.M., 2002. The Tools of Government: A Guide to the New Governance. Oxford University Press, New York.

Salzman, J., 2005. Creating markets for ecosystem services: notes from the field. New York University Law Review 80 (600).

Samuelson, P.A., 1954. The pure theory of public expenditures. The Review of Economics and Statistics 36 (4), 387–389.

Stone, D., 2002. Policy Paradox: The Art of Political Decision Making. W.W. Norton & Co., New York.

Ten Kate, K., 2002. Global genetic resources: science and the convention on biological diversity. Science 295 (5564), 2371–2372.

Turnbull, G.K., 2004. Development moratoria. Journal of Housing Economics 13 (3), 155–169.

Turner, R.K., Paavola, J., Coopera, P., Farber, S., Jessamya, V., Georgiou, S., 2003. Valuing nature: lessons learned and future research directions. Ecological Economics 46, 493–510.

Turpie, J.K., Marais, C., Blignaut, J.N., 2008. The Working for Water Programme: evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. Ecological Economics 65, 788–798.

Wunder, S., 2005. Payments for environmental services: some nuts and bolts. CIFOR Occasional Paper, No. 42.

Wunder, S., Albán, M., 2008. Decentralized payments for environmental services: the cases of Pimampiro and PROFAFOR in Ecuador. Ecological Economics 65, 685–698.

WWF, 2006. Payments for Environmental Services: An Equitable Approach for Reducing Poverty and Conserving Nature. World Wide Fund for Nature, Switzerland.

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