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LOCALIZING DEMAND AND SUPPLY OF ENVIRONMENTAL SERVICES: INTERACTIONS WITH PROPERTY RIGHTS, COLLECTIVE ACTION AND THE WELFARE OF THE POOR

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ABSTRACT

Payments for environmental services (PES) are increasingly discussed as appropriate mechanisms for matching the demand for environmental services with the incentives of land users whose actions modify the supply of those environmental services. While there has been considerable discussion of the institutional mechanisms for PES, relatively little attention has been given to the inter-relationships between PES institutions and other rural institutions. This paper presents and builds upon the proposition that both the function and welfare effects of PES institutions depend crucially on the co-institutions of collective action (CA) and property rights (PR).

Experience from around the developing world has shown that smallholder land users can be efficient producers of environmental services of value to larger communities and societies. However, experience also shows that the international and national institutions that govern PES are often designed in ways that entail transaction costs that cannot be feasibly met by individual smallholders. Collective action can provide a mechanism for farmers to coordinate actions over large areas to provide environmental services such as biodiversity and watershed protection. Collective action also offers the potential to reduce the costs of monitoring and certification usually required to obtain payments for the services. However, the nature of the environmental services will influence the scale and type of collective action needed, the bargaining power of smallholders, and the investment or reinvestment requirements.

The relationships between property rights and environmental services are more complex. The creation of PES institutions itself actually represents the creation of new forms of property and responsibility, with all of the tensions and tradeoffs that are entailed. How are balances struck, for example, between people's responsibilities not to pollute and the need to compensate people for foregoing polluting activities? What about balances between constitutional rights to safe environment and the right to earn a livelihood?

In carbon sequestration arrangements, secure property rights are often seen as a necessary pre-condition for binding contracts, even though collective forms of property may generate high quality environmental services. On the other hand, environmental services can influence property rights, notably where land or water tenure are given as rewards for certain types of services, land use, or stewardship. The type of environmental service, and the possibility of exclusion it provides, is also likely to influence the type of property rights.

This paper presents a conceptual framework that clarifies the inter-linkages between property rights, collective action, payment for environmental services, and the welfare of smallholder land users. The framework is centered on concerns of function and welfare effects of PES. The functional perspective clarifies the effects of collective action and property rights institutions on the supply of environmental services. The welfare perspective considers smallholders as one of several potential sources of supply,

sometimes directly competing against large landowners and public sector providers. Using this conceptual framework can help to identify conditions under which smallholders are likely to be able to participate in payment for environmental services schemes. Greater consideration of the linkages between PES and other rural institutions can lead to more equitable outcomes, particularly by 1) suggesting how collective action can be used to overcome transaction costs and barriers to participation by smallholders, and 2) identifying mechanisms through which managers of small private parcels or areas of common property can be rewarded for environmental stewardship through PES.

Key words: Payment for environmental services, poverty reduction, collective action, property rights, rural institutions, smallholders, welfare effects

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Localizing Demand and Supply of Environmental Services: Interaction With Property Rights, Collective Action, and the Welfare of the Poor

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1. INTRODUCTION

Balmford et al. (2002) estimated a global benefit-cost ratio of approximately 100:1 in favor of conserving key ecosystems, species and resources. Various imperfections in the real world constrain environmental conservation: imperfections of governments, imperfections of markets, and imperfections of local collectives. While most economists recognize that markets for environmental services will remain imperfect and cannot be the only solution to environmental problems, there continues to be strong interest in institutional mechanisms that better harness market forces to match demand for environmental services with the incentives of land users whose actions modify supplies of environmental services. The potential benefits of market-based approaches often referred to include improved resource conservation, more sustainable sources of conservation finance, greater environmental justice in the distribution of conservation benefits and costs, and new and sustainable sources of income for poor people in developing countries. The practical and theoretical case for payments for environmental services in developing countries is laid out in several recent works, including Pagiola, Arcenas and Platais (2005) and Landell-Mills and Porras (2002). Van Noordwijk, Chandler and Tomich (2004) discuss the conceptual basis of rewards for environmental services from various perspectives and conclude that a location-specific blending of

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rights, obligations and rewards is needed as long as the essential 'preconditions' for market-based payments are not met in large parts of the developing world.

The last decade has seen increased interest in payments for environmental services (PES) such as biological diversity conservation, carbon sequestration and watershed protection, particularly in developing countries. A number of experimental programs have been initiated, many with startup finance from private foundations (e.g. Shell Foundation, FACE Foundation, Mercedes-Benz, Dow Company Foundation) and support from development agencies such as the UK Department for International Development, the International Fund for Agricultural Development, and the United States Agency for International Development. The United Nations Framework Convention on Climate Change (UNFCCC) is generating new interest in PES mechanisms that reward countries for reducing net carbon emissions. For example, the World Bank has established the BioCarbon Fund and Community Carbon Fund to support experimental programs for carbon sequestration.

While high profile payment for environmental service programs have emerged in Costa Rica and other Latin American countries (Pagiola, Arcenas and Platais 2005), elsewhere in the developing world they remain relatively uncommon. Nonetheless there is a growing number and variety of other forms of compensation or rewards for environmental services being explored. Direct monetary payments can be considered an extreme form of market development, bringing together the supply and demand for specific environmental services. Other less direct and less specific reward mechanisms can also usefully be analyzed in terms of their supply and demand characteristics. In this paper we analyze markets for environmental services from the perspective of the new

institutional economics (Ruttan and Hayami 1984; North 1990). We focus particular attention on the institutions of collective action and property rights.

The framework we present is centered on concerns of function and welfare effects of PES. The functional perspective helps to clarify the effects of collective action and property rights institutions on the supply of environmental services. The welfare perspective considers smallholders as one of several potential sources of supply. Using this conceptual framework can help to postulate conditions under which smallholders are likely to be able to participate in payment for environmental services schemes. Greater consideration of the linkages between PES and other rural institutions can lead to more equitable outcomes, particularly by 1) suggesting how collective action can be used to overcome transaction costs and barriers to participation by smallholders, and 2) identifying mechanisms through which managers of small private parcels, and even common property managers, can be rewarded for environmental stewardship through PES.

The paper proceeds as follows. Section 2 presents a brief description of the environmental services considered in this paper: – watershed protection, biodiversity conservation and carbon sequestration. We then develop a conceptual framework for linking factors that have been suggested as constraints or facilitating factors in the development of markets for environmental services to the institutions of property rights and collective action, and the likelihood of smallholder involvement. Section 4 of the paper describes some of these relationships in more detail, with reference to experience that has been accumulated with PES in the developing world. Section 5 applies this framework to watershed protection, biodiversity conservation and carbon sequestration,

and the final section draws implications for PES mechanisms to contribute to poverty reduction among smallholders.

2. ENVIRONMENTAL SERVICES, LAND USE AND SMALLHOLDER FARMERS

The paper focuses on three environmental services – watershed protection and rehabilitation, biodiversity conservation and landscape restoration, and carbon sequestration and protection of existing carbon stocks. All three services have aspects of 'conservation' and 'rehabilitation' that have consequences for the institutional context of reward mechanisms, leading to six different service reward situations. Most of the PES schemes currently in operation cover one or more of these three groups of services (Mirinda, Porros and Luz Moreno 2003). Landscape beauty and spiritual values as a basis for ecotourism will not be discussed in this paper. This section presents a brief description of these services, with an emphasis on the nature of the service and how land use might affect the service. The next sections will highlight differences between the services that affect the function and welfare implications of PES mechanisms.

Watershed protection refers to a set of land uses that preserves the integrity of a watershed to yield water that is relatively free of pollutants, low in sediment, and buffered against flash floods relative to the pattern of rainfall and without large fluctuations in dry-season and groundwater flows. Watershed rehabilitation aims at returning a landscape to a condition where it can again provide these services after a period of degradation. Watershed protection is often equated with forest protection, based on the simple understanding that forest landscapes act as sponges and filters that reduce

runoff, store water, and remove sediment and pollutants. Many forest protection, resettlement and afforestation programs are based on this premise. The empirical evidence suggests, however, that the relationships between tree cover and watershed function are more complex. Land use types other than natural forest may be able to provide these 'forest functions', while planting fast-growing trees in the foresters' approach to reforestation is unlikely to return a landscape to the original forest condition. At the plot scale, runoff and erosion depend on ground cover, soil structure, and topography, while at the landscape scale, runoff and sedimentation depend upon the relative location of sources, lateral flows and sinks of water, soil and nutrients (Swallow et al. 2002; Ranieri et al. 2004; Bruijnzeel 2004; van Noordwijk et al. 2004). Land use has large impact on watershed function in certain locations within the landscape, particularly in riparian areas, wetlands and hillside areas. Strategically located vegetative filters and conservation structures will often be more effective than general reforestation. In drier climates, water harvesting structures may have positive impact in situations where general re- or afforestation programs may be counter productive.

PES schemes for watershed protection have emerged in all regions of the world. Supported by government regulations and public investments, suppliers of domestic and industrial water and hydropower provide incentives to land users in the catchment areas to adopt practices that are expected to minimize chemical pollutants and sediment loads.

Appleton (2004) describes the famous case in which New York City negotiated with farmers in the 8,300 square kilometer Catskills – Delaware catchment area to maintain the quality of water supplied to residents of New York City. After a series of negotiations and shared vision exercises, New York City agreed to provide finance for the human resource and capital inputs required to develop Whole Farm plans for reducing

pollution. The resulting program was voluntary at the individual farm level, but required that at least 85 percent of farmers participate. New York City agreed that many normal environmental regulations would be waived in the area, except for prohibitions on willful pollution. Within five years, 93 percent of farmers in the catchment enrolled in the program. The New York City water company engaged in these negotiations as they were legally obliged to invest in water purification in the absence of restrictions on farming in the catchment area. It was not concerns over water quality as such, but the legal requirements based on expected (rather than measured) relationships with land use that motivated the company to look for less costly solutions. In the absence of such legal obligations and a track record of law enforcement, the 'market based' mechanisms would not have emerged.

Pagiola, Arcenas and Platais (2005) describe several of the watershed management PES schemes that have been put in place in Latin America. The ICRAF-led RUPES program is supporting several pilot PES projects for watershed protection across southeast and south Asia (www.worldagroforestry.org/SEA/networks/rupes). The RUPES program is giving particular attention to the potential for poor upland farmers to benefit from environmental service mechanisms.

Biodiversity conservation refers to the preservation and resilience of valuable ecosystems, plant and animal communities, and individual plant and animal species. Land use affects biodiversity at all of these scales. It is well known that agricultural land use shapes agrobiodiversity – the diversity of plants, insects and soil biota that sustains agricultural production and the resilience of agricultural systems. Agricultural land use and farming practices also affects wild biodiversity at the landscape level. Relative to monocrop agriculture, positive effects on biological diversity have been noted for a

variety of farming practices including integrated pest management, organic agriculture, agroforestry, conservation farming and pastoralism (McNeely and Scherr 2002). Specific types of agroforestry systems, for example, have potential to foster wild biodiversity by providing corridors between protected areas, providing habitat conducive to wild fauna and flora, and reducing human pressure on protected areas (Schroth et al 2004; Donald 2004). Multi-strata damar and rubber agroforestry systems in Sumatra, Indonesia, foster plot-level levels of plant diversity that rival the levels found in nearby primary rainforests (Tomich et al. 2001). At landscape scale, however, there are both qualitative and quantitative differences in the biodiversity supported by these agroforests and the former natural forest (Beukema and Van Noordwijk 2004). In Africa, there are several examples in which smallholder farmers have been compensated for adopting land uses that foster conservation of wildlife with high tourism value. Perhaps best known are the CAMPFIRE program in Zimbabwe and some of the group ranches in Kenya.

Carbon sequestration is the absorption and long-term storage of atmospheric carbon in woody biomass and soils against some baseline situation, often restocking after earlier degradation. To reduce emissions, efforts have focused on preventing the degradation of carbon stocks in above-ground vegetation or peat soils, whereas carbon stocks in mineral soils tend to be more resilient. Tree growth and land uses that sequester net amounts of CO_2 from the atmosphere may contribute to net reductions in greenhouse gas emissions, depending upon the impacts on other greenhouse gases. The main interest of 'buyers' in the carbon market derives from the international agreement in the United Nations Framework Convention for Climate Change (UNFCC) subscribed by most countries and the specific implementation agreement of the Kyoto protocol that became legally binding on February 16 2005 for all but the largest net emitters of CO_2. The Clean

Development Mechanism (CDM) of the Kyoto Protocol creates opportunities for Annex 1 countries with high CO_2 emissions to meet part of their emission reduction targets by supporting "clean development" in non-annex 1 developing countries that have ratified the protocol without undertaking specific commitments regarding their net emissions. Market mechanisms apply to 'credited emission reduction' (CER) testimonies rather than to carbon storage per se. The CDM is mostly concerned with the transfer of technologies that replace fossil fuels or at least increase the efficiency of generating energy currently derived from carbon sequestered in a geological past. The use of biofuels is a positive contribution as it substitutes for fossil fuel use.

After protracted international negotiations, CDM also covers carbon sequestration through reforestation and afforestation, with many safeguards against misuse of the mechanisms. These safeguards, however, tend to substantially increase the transaction costs. Key challenges in CDM projects are the establishment of credible baselines (negative, neutral, positive or non-linear), the temporary nature of the credits for new carbon stocks, assurance of additionality that a positive difference with the baseline can be attributed to a particular project or investment rather than to existing market forces, and control of negative "leakages" outside of the project area (Climate, Community and Biodiversity Alliance 2004).

A range of mechanisms outside of the rules of the Kyoto protocol for the 2008-2012 commitment period is also being explored, with expectations that they can be mainstreamed for the commitment period beyond 2012. Several of these mechanisms

include options for conserving existing carbon stocks[4] and the bundling of carbon services with watershed protection and biodiversity conservation that currently are constrained by the additionality rules. For the longer run a convergence of the result-based rules applied within Annex 1 countries of the Kyoto protocol and those that apply to developing countries will be needed, but progress in the diplomatic negotiations depends on linkage with other issues of (lack of) trust between countries.

Pilot carbon sequestration projects with smallholder farmers outside of current CDM rules have been promoted in several developing countries, including Mexico, India, Indonesia, Uganda, Tanzania and Mozambique. The Edinburgh Centre for Carbon Management promotes the Plan Vivo approach developed in Mexico for linking individual farmers with voluntary purchasers of carbon emission reductions (DTZ Pieda Consulting 2000). In Indonesia pilot schemes in carbon-rich peat swamps have provided micro-credit for agricultural development with repayment of the loan via demonstrated success in survival of trees planted.

Relative to watershed functions and biodiversity, the carbon market is the most global and has most resemblance to commodity markets. Even so, the carbon 'market' shows that 'demand' for emission reduction certificates strongly depends on the institutional framework of (voluntary, negotiated) obligations. The 'supply' of these credits requires national institutions that guard against a predominance of external benefits, but that run the risk of pricing a country out of the market.

In all the above we need to distinguish between the local demand for a demonstrable service (e.g. clean water), concern for the public image of countries or

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[4] This raises greater concerns over leakage, but has potentially much larger impact on net emission reduction.

companies, and the more 'global' concepts of reducing overall impacts via the concept of 'off-sets'. Such off-sets involve a linkage between environmental damage in one location and improvement or protection against demonstrable threats elsewhere. Offsets depend on the supply and demand for rules in the slow process of institutional development. The public image depends on the highly volatile market of supply and demand for 'feel-good' factors of affluent consumers.

3. A FRAMEWORK OF FUNCTION AND WELFARE EFFECTS OF PES

Current PES projects and pilot schemes seek to foster the creation or expansion of markets for environmental services. That those markets did not exist before necessarily means that there have previously been some obstacles to the operation and efficiency of those markets. We first describe ten factors that have been postulated as factors constraining the development and function of ES markets – using the term in a broad sense of a mechanism to match supply and demand by adjustment of the level of rewards.

1. *Legal basis and restrictions / fixed costs of market development:* Most of the demand for carbon sequestration 'off-set' is based on legally binding commitments to reduce environmental problems of development. The supply of marketable services depends upon legal baselines of 'acceptable' levels of environmental damage, as only provision above such baseline is marketable. In many cases, national laws and local institutions that affect environmental governance constrain ES markets by lack of clarity of obligations for the buyers, lack of realistic baselines of acceptable levels of environmental damage, and high regulations on transactions. Such constraints may be found in laws related to environment, agriculture, water, or local government institutions. International agreements, bilateral contracts, international donors, and international experience may

create new opportunities for ES markets, but these do not immediately override national and local restrictions.

2. *Costs of excluding freeriders from benefit streams:* Compared to conventional marketed goods, environmental services have a higher cost of outsiders from ES benefit streams. For example, some of the benefits of biodiversity conservation accrue to people who place a value on the existence of threatened species and ecosystems, whether or not they have paid for the conservation. Global warming and ozone layer depletion are global phenomena: mitigation of greenhouse gas emissions thus generates benefits across the global community. This public good nature of ES has been used as a justification for inter-governmental collective action, resource management by government agencies, and regulation of resource use through government environment agencies. Mobilizing more individualized sources of finance for PES often requires legal and organizational frameworks that can assign and enforce private responsibility for environmental damage (eg following the polluter pays principle), as well as more individualized rights to the benefits of ES (although not necessarily to partner resources). The buyers of environmental services may not be interested in the environmental services, per se, but in certification that they are adhering to government regulations, or in a positive public image.

3. *Small demand for ES:* Many environmental services have been characterized by small effective demand from the beneficiary populations. Early studies of the Environmental Kuznets Curve supported a hypothesis that demand for a safe environment was very low for countries with low to middle income, but much higher for middle-to-higher income countries. This implies that ES are luxury goods and that economic growth is perhaps the most important solution to environmental degradation. More recent analysis of disaggregated data suggests that even low-income people demand environmental services, that changes in environmental awareness are important, and that the structure and function of environmental management institutions have major effects on demand for ES (Dasgupta et al. 2002; Stern 2004; Kuuluvainen 2002). Population growth and concentration also increases demand for clean water, and settlement of people in areas affected by floods can increase demand for watershed services. In some cases, people

may express these demands through political processes that favor tighter environmental laws.

4. Transaction costs of market function / market entry and validation of ES: Two major categories of transaction costs can pose major obstacles to functional markets for environmental services: negotiation costs and enforcement costs. Negotiation costs include the time, social and financial costs of organizing buyers and seller into operating units, as well as the costs of establishing contact, preparing the necessary documentation, and negotiation between buyers and sellers. Enforcement costs include the costs of certification, monitoring and enforcement of contracts between buyers and sellers, and among groups of buyers and sellers. Krey (2005) has measured the transaction costs associated with CDM projects in India, and found very clear evidence of declining transaction costs per unit of carbon dioxide emission reduction, with costs ranging from 0.07 to 0.47 $US / tonne of carbon dioxide. These costs of validating transactions can limit market entry. One of the goals of the RUPES project is to establish methods for cost-effective measurement of ES and the links between ES and resource use (www.worldagroforestry.org/SEA/Networks/RUPES).

5. Small number of ES buyers or sellers with large share of the market: Concentration in the supply or demand for environmental services could hinder or enhance markets for environmental services. On the positive side, single firms that stand to benefit from the supply or demand of environmental services may have greater incentive to incur the negotiation and enforcement costs associated with new contractual arrangements with widely dispersed farming communities. This seems to have contributed to the development of the innovative approach to watershed management instigated by New York City. On the negative side, a high concentration among supplies of environmental services may limit the possibility for smallholders to participate effectively.

6. *Functional relation between effort and ES supply:* There is large variation among environmental services, and the knowledge base on what factors affect ES supplies is limited and context specific. This is particularly the case where there are important threshold effects and non-linear relations. Among the three environmental services considered in this paper, carbon sequestration is the environmental service with the most certain and linear functional relationships with resource use.

7. *Spatial specificity in ES supply:* Some environmental services (eg carbon sequestration) have many alternative sources, while others (eg preservation of particular habitats) are highly specific to particular sites. These differences determine the size of the market of ES, the spatial specificity of markets, and the extent of competition to meet ES demand.

8. *Time path of ES production as a result of land use choices:* some environmental services are produced through one-off actions, while others are produced through actions which must be kept in place or renewed indefinitely. For example, replacing a non-renewable energy source with a renewable energy source (such as from diesel to wind generation of electricity) produces a permanent net reduction in greenhouse gas emissions, while trees planted to sequester carbon as wood do so only as long as the wood is not burned.

9. *Key partner resources for ES supply:* ES normally require "partner resources" that are necessary for supply. Resources that are most essential and tangible, such as land, will tend to be given special focus by the potential demanders of environmental services. Other partner resources may be less tangible, such as appropriate skills, knowledge and capacity to enter the market.

10. *Time path of ES payments:* Payments that regularly reward ES supply have different implications than one-off payments, with one-off payments better suited for financing fixed costs and achievement of thresholds. Of course, on their own, one-off payments do not address the challenge of long-term compliance or the reversion to previous land use. Reward mechanisms – both one-off payments and regular rewards – are most likely to have sustained impact on farmers' behavior if they change the overall incentive structure in favor of land uses consistent with ES supply.

Table 1 presents a summary of how those factors may be related to property rights to environmental services and partner resources, collective action among smallholders, and the welfare of smallholders. The following section gives more details and illustrations of these in developing countries.

Table 1--Links between ES market constraints, property rights, collective action and smallholder welfare

Constraint to function and participation in ES market	Link to security and distribution of property rights (PR)	Link to collective action among smallholders (CA)	Link to conditions of smallholders
1. Legal restrictions / fixed costs of market development	Institutions for secure rights are pre-condition for ES market; Changing legal restrictions often involves the de facto creation of a new property right	CA to lobby for / against institutional change	Entry costs may be prohibitive for smallholders; PR changes may benefit smallholders
2. Costs of excluding freeriders from benefit streams	Case for public ownership & / or management	Public ownership / regulation may spur collective opposition or negotiation with government	Many smallholders reside in public land
3. Small demand for ES	Little direct link	Little direct link	ES demand likely to increase with income and population
4. Transaction costs of market function / entry	Secure rights as pre-condition for entry into ES market	CA to reduce average costs of transactions and validation	Variable costs may be prohibitive for smallholders
5. Small number of ES buyers or sellers with large share of the market	Largeholders more likely to have secure rights	CA to compete with largeholders or counter power of single buyer	Difficult for smallholders to compete
6. Functional relation between effort and supply of ES	Tenants and sharecroppers may have little incentive to adopt land uses that produce ES. Common property may facilitate the achievement of thresholds and scale economies.	CA in supply to achieve thresholds & scale economies	Increasing returns to ES supply may exclude smallholders
7. Spatial specificity in ES supply	PR to high impact spaces may be most contested; high specificity to places with weak PR may foster PR change	Challenge to organize around high impact spaces	Smallholders often located in high impact spaces
8. Time path of ES production as a result of land use choices	Returns far into future make secure PR more important	CA may facilitate pooling and temporal evening of returns	Smallholders may have shorter investment horizons

Table 1--Links between ES market constraints, property rights, collective action and smallholder welfare (continued)

9. Key partner resources for ES supply	Determines what resources PR are needed for; potential for secure PR as a PES	little direct link	Smallholders may have more secure rights to some resources than others
10. Time path of ES payments	One-off payments may finance changes in PR but not recurrent costs of secure PR	One-off payments may finance CA organization but not operations	Smallholders may discount future payments highly

4. INSTITUTIONS AND THE FUNCTION OF PES MECHANISMS

PROPERTY RIGHTS AND PES

Property rights as a necessary condition for ES markets

Environmental service mechanisms that link private purchasers with private or collective suppliers of those services are usually supported by an explicit contract that increases the accountability of the suppliers to the performance of agreed-upon actions. Contracts usually require that the ES providers have clear and secure rights to perform the agreed-upon actions on that land (Climate, Community and Biodiversity Alliance 2004).

Property rights do not need to be individual in order to allow environmental service mechanisms to proceed. Contracts with individual farmers will require individual property rights, while contracts with groups of farmers may be more effectively secured with group rights. Indeed, group title may be more effective for environmental services that have minimum scale and threshold effects such as biodiversity conservation

The requirement of secure property rights, as commonly stated in terms of land ownership, may have the effect of excluding groups of people and even countries from environmental service mechanisms. For example, the constitution of Ethiopia prohibits individual freehold title to land and, until recently, farmers could be made to engage in land redistribution. In northern Costa Rica, smallholders who had received their land under the Agrarian Development Institute program for small farmers were not entitled to receive PES for watershed management. Environmental service mechanisms may also threaten the property rights of poor and marginalized populations. Greig-Grann and Bann (2003, p. 37) caution that if communities do not have secure rights in an area suited

for PES mechanism, then it is possible that other people with better connections will take over from the communities.

On the other hand, the necessity to have secure property rights may encourage agencies involved in the formulation of the schemes to secure property rights as an early part of the programme. For example, the PAMB (Protected Area Management Board) programme in the Philippines recognizes the need for farmers to be provided secure tenure in order for them to be effective partners in the co-management of protected areas. It is issuing "tenurial instruments" to all migrants who have occupied the land for at least 5 years before the programme was initiated. This covers a huge part of the Philippines (Rosales 2003, pp. 35-45, see esp. box on p.43).

Property rights and the time path of ES production and payments

ES demands that can be satisfied through one-off purchases of services already rendered or to be rendered in the near future, such as energy projects that replace non-renewable with renewable energy sources, may not require secure property rights as much as ES demands that must be met through periodic and indefinite payments, such as carbon sequestration projects.

Secure property rights to partner resources as a payment for ES production

In situations where the production of environmental services requires long-term commitment of land resources, land tenure security may be a very important determinant of the production of environmental services. In such cases, stronger and more secure rights over land and other partner resources can be used, instead of or in addition to other payments, as a reward for environmental services (RES). This means that land tenure is conditional upon ES provision. This can occur where the state claims rights over the

land, and has not recognized the rights of "squatters" (even those who have been using the land for generations). In Indonesia, new social forestry agreements (*Hutan ke-masyarakatan* in Bahasa Indonesia or HKm) increase security of tenure for poor upland farmers in exchange for their commitment to land management agreements (Suyanto et al. 2004). In the Maasin watershed in the Philippines, farmers participating in the CADT / CALT scheme (Certificates of Ancestoral Domain Title / Certificates of Ancestoral Domain) were given 25 year tenure under the terms of a community based forest management programme (Rosales 2003; Tecsen 2004). Even where farmers have some recognized rights, participating in an ES program may strengthen their property rights. In the Virilla watershed in Costa Rica, people who enrolled in the programme experienced more secure land tenure because they are protected against land incursions. Thirteen percent of participants said that the main benefit of being involved is the reduced threat of land invasions (Miranda et al. 2003, p. 36).

Functional relation between effort and supply of ES

The form of property rights can shape the opportunities for different types of ES and ES mechanisms. For example, communal tenure in Maasai group ranches is consistent with community tourism, as in Olagasali in Kenya, whereas community tourism is more difficult where land has been privatized.

Property rights to key resources

Some environmental services, particularly watershed function and biodiversity conservation, are heavily dependent upon key resources such as wetlands, riparian areas, corridors and buffer zones. One of the dilemmas of ES supply is that this high environmental value also justifies public ownership of those resources. If public

resources are well managed, and regulations enforced, then this might lead to high levels of ES supply. On the other hand, if such public resources are poorly managed, then the resources may be overused and poor levels of ES produced. In such circumstances, it becomes very important that the public sector concentrates on key resources where it has comparative advantage and encourages collective and private management of other resources. In the uplands of Sumatra, for example, research by CIFOR and ICRAF has shown that large tracts of gazetted forest lands no longer have any tree cover because they have been burned and cleared by farmers. Farmers operating on plots without secure tenure tend to practice extractive short-duration agriculture, while farmers operating on plots with secure private title tend to practice complex multi-strata agroforestry systems. In those areas, the agroforestry systems are associated with higher levels of profit, greater carbon stocks, and higher levels of biological diversity than short-duration agriculture (Tomich et al. 2001).

PES and the creation of new property rights to environmental services

The creation of PES institutions itself represents the creation of new forms of property, with all of the tensions and tradeoffs that are entailed. For example, watershed protection payments create a new benefit stream related to land use. How should these rights over this benefit stream be allocated? This has not only equity implications, but also affects the structure of PES mechanisms. Where does one draw the line, for example, between those who should be rewarded for providing clean water and those who have a duty not to pollute? Van Noordwijk, Chandler and Tomich (2004) use the traffic light analogy. Rewards in the 'red' zone would entail paying criminals not to commit crimes and as such are not easily accepted. The 'yellow' zone between minimally

acceptable practices and the second baseline can be subject to negative 'rewards' in the form of taxes, with only the 'green' zone above the second baseline eligible to rewards. The baselines are not objectively established entities, but are subject to change and negotiation depending on where an environmental issue is in the 'issue cycle' of public awareness and commitment to deal with it. In fact, market mechanisms of supply and demand may work on the position of these baselines as much as they work on the rewards themselves. Unfortunately, in much of the developing world the regulation of minimally accepted behavior has progressed much faster than the adherence to rules and development of effective, non-corruptible enforcement mechanisms. Current practice may often be, legally, in the red zone, leading to situations in which rewards for local 'guardian' roles replace the failing enforcement of (unrealistic?) rules.

In a few cases ES property rights have been formally created through legislation, such as 1998 legislation in New South Wales, Australia that established property rights to forest carbon services, which are defined as tradable interests in the carbon sequestration potential of forests. Forestry covenants are used to guarantee that landholders will maintain land in forest cover in exchange for carbon sequestration payments (Rosenbaum, Schoene and Mekouar, 2004). In most cases (as with most property), the rights are evolving. The experience from other types of property rights can offer important lessons for ES property rights.

Even if laws are passed to define property rights over ES, the rights will not be effective property rights unless they are accompanied by effective enforcement. Enforcement can come from a range of international, state, local or customary institutions. However, international bodies are unlikely to have a strong presence on the

ground in many of the places where ES provision is most critical. Experience with forest, water, and rangeland management indicates that neither state nor local bodies are likely to be able to enforce such property rights alone, and that some type of co-management regime will be most effective. Cultural or religious norms can also come into play as enforcement institutions. For example, "sanctifying" a forest by dedicating it to the local deity in India invokes divine oversight, and enhances people's respect for the rules or fear of punishment (Aggarwal 2002). Similarly, Maasai cultural taboos on eating wild animals strengthen biodiversity conservation.

Property rights are found to be most valuable, and create the strongest incentives for resource management, when they are secure. But how would tenure security of rights over environmental services be defined? Definitions provided by Place, Roth and Hazell (1993) and Roth, Wiebe and Lawry (1993) highlight the importance of breadth (the number of bundles of rights one holds), duration (time frame), and assurance (robustness of rights in the face of competing claims). Applying this to environmental service rights implies the need to look carefully at who holds not only rights over benefit streams from the resource and payment for the resource, but also who holds decision-making rights, and the extent to which right-holders can exclude others. Duration implies the need to look at long-term assignment of rights, and assurance requires attention to enforcement institutions, as discussed above.

COLLECTIVE ACTION AND PES

Collective action and the functional relation between effort and ES supply

The functional relation between effort and supply of environmental services affects the potential benefits of collective action in supply. Services with a proportional

or more-than-proportional observable relationship with effort may require less collective action than services that require landscape scale efforts or involve non-negligible thresholds before they emerge. Carbon sequestration benefits are approximately proportional to the amount of land involved; the contribution of one farmer growing trees on one hectare is approximately the same, whether or not neighboring farmers grow trees. Rules about tree planting, however, may introduce thresholds and non-linearities. Species counts have often been observed to increase at an increasing rate as the area targeted in an ecosystem grows larger. When this is true, biodiversity protection will involve more-than-proportional benefits. Other biodiversity functions, however, have important threshold effects, meaning that if not adopted on a large enough area, the benefits are not realized at all (Landell-Mills and Porras 2002). For example, landscape corridors only play a function if they are sufficiently connected with centres of biodiversity. Such situations require coordination among neighbors. Water quality may be the ultimate example of the necessity of full compliance and collective action, as a single source of pollution can make the efforts of a large number of actors meaningless. Collective action provides a mechanism for farmers to coordinate their actions over a large area to provide environmental services such as biodiversity and water services.

Collective action and the costs of PES mechanisms

Even where the provision of the ES is not "lumpy" due to critical thresholds in supply, collective action may be important to reduce the transaction costs of verification and payment for PES systems. Experience from around the developing world has shown that smallholder land users often are both important and efficient producers of the environmental services of value to larger social groups (Tomich et al. 2001; Schroth et al.

2004; McNeely and Scherr 2003). But experience also shows that the international and national institutions that govern PES are often designed in ways that entail transaction costs that cannot be feasibly met by individual smallholders. There are often economies of scale in contracting, monitoring, and making payments that favor larger suppliers such as plantations over many individual smallholders. However, when smallholders group together in cooperatives or other forms of user groups, they can achieve some of these economies of scale. Effectively, the cooperatives assume the transaction costs of developing and enforcing contracts with individuals, so that the PES implementing agency does not have to. In some cases, the PES may even be channeled through producer cooperatives as a premium price of output for "certified" producers. For example, the premium price paid for fair trade, shade-grown, organic coffee provides smallholders in Oaxaca an incentive for biodiversity conservation, which is compatible with shade-grown coffee. The cooperatives negotiating with purchasers also undertake the costs of certification.

Collective action and bargaining power in PES mechanisms

Collective action could also strengthen the bargaining power of smallholders relative to other producers of environmental services and buyers of environmental services. In the Sumber Jaya area of Sumatra, farmers' groups have been very important for providing voice to upland farmers previously considered to be squatters on public land. In negotiations for new HKm social forestry agreements, the farmer groups have been effective in convincing local officials that they are concerned about the environment and are willing to adopt land use practices that have been documented to produce high levels of environmental services. Farmers' groups often need assistance with such

negotiations, however, since they normally are formed for other purposes and are unfamiliar with the concept of producing environmental services through their farming activities.

PES schemes affecting collective action

The nature of environmental service payments can also influence collective action. Conventional regulatory approaches stress enforcement and negative penalties. Demanders have a feeling of entitlement, and expect public agencies to assume the responsibility to deliver services or protect against negative impacts. Under a regulatory regime, collective action among suppliers may even be to evade the rules and enforcement, rather than collective action to enforce the rules, especially if the rules do not have local legitimacy. By contrast, PES offers positive economic and other incentives for ES provision. These offer greater potential for collective action to enforce the rules and provide the service.

PES AND THE POTENTIAL FOR POVERTY REDUCTION

As with many other "new" resources (i.e. those which have suddenly become more valuable, and do not yet have clearly established claims), PES has generated considerable enthusiasm on the part of those who hope that it might provide income streams or other benefits to poor people. Yet experience to date indicates that this is far from assured (Landell-Mills and Porras 2002). In general the poverty impact of PES will depend on whether poor people are potential suppliers of ES and whether they can take advantage of PES mechanisms.

Spatial patterns of ES supply and poverty

The spatial pattern of supply – demand interaction will determine how specific or general are the pools of potential suppliers and potential demanders for the service. The consumers of some environmental services demand services that can only be provided by potential suppliers living in specific locations, while consumers of other environmental services demand services that could be provided by suppliers almost anywhere in the world. Potential demanders are more likely to be willing to incur the higher transaction costs of working with smallholders for services that are specific to locations where smallholders form a majority of the population. In many parts of southeast Asia and Latin America, the areas with highest value for biodiversity conservation and watershed protection tend to populated by relatively poor people. Traditional approaches to conservation and land classification may be partially responsible for these situations. Escobal and Torero (1999) show that the high levels of poverty that exist in the highlands of Peru are largely explained by their low levels of private and public assets. In Indonesia, Thailand and the Philippines, most upland areas have been designated as forest domain that should be reserved for the generation of environmental services and not settled for farm production (Fay and Michon 2003). The tens of millions of people who have settled (illegally in some cases) in such areas have deliberately not been provided with public infrastructure or services.

Viewing the upland poor as providers of environmental services thus requires a significant paradigm shift away from traditional approaches to environmental regulation. Traditional approaches generally try to enforce the approach of segregation: exclude people from areas important for environmental services, and do not expect areas with

high numbers of people to produce environmental services. While in some instances, certain environmental services may indeed be efficiently provided through the segregation of people and protected areas, other environmental services may be efficiently provided by the integration of agriculture and non-agricultural land uses (Van Noordwijk *et al.* 1997). For example, flooded rice fields can provide habitat for migratory waterfowl, and natural vegetative strips in the Philippines creates habitat for wild flora and fauna (McNeely and Scherr 2003) On the other hand, conservation of mega-fauna like tigers, gorillas and elephants may be best accomplished by designating certain protected areas, and working with farmers in the buffer zones to provide connectively and reduce pressure on the protected area.

Resources of the poor to participate in ES mechanisms

One factor that may constrain the ability of the poor to participate in environmental service mechanisms is lack of access to sufficient resources to devote to environmental service provision. Smallholders facing subsistence constraints face a high opportunity cost in setting aside a substantial portion of their land, which they need to live on. .For example, in the Virella watershed in Costa Rica, Miranda, Porres and Luz Moreno (2003) found that only people with large land holdings were willing to dedicate part of their holdings to conservation. Large disparities in land holdings and security of tenure are likely to exacerbate the bias against smallholders. Wherever effective control of over land is the basis of environmental services, very specific agrarian interventions will be needed to achieve 'pro poor' impacts. However, where labour or effort is involved, pro-poor mechanisms can be more easily envisaged.

Empowerment or exclusion of the poor through PES mechanisms

Environmental service reward mechanisms generally entail some shift in attitude toward rural people whose resource uses affect the environment. Traditionally, rural people living in or near protected areas have been viewed as troublesome squatters; evicting them or sharply curtailing their land use activities (through "fines and fences" approaches) were seen as the best way to improve land management. Rewards for environmental services represent a fundamental shift in perspective, with rural land users treated as land stewards who should be compensated for providing positive externalities. Rewards for environmental services builds on the idea of creating goodwill with residents of environmentally sensitive areas and takes the additional step of providing those residents with incentives to protect the landscape. However, there is also the very real possibility that, if PES mechanisms are very remunerative, they will create an incentive for elites to take over the land (Grieg-Gran and Bann 2003), Thus for PES mechanisms to address poverty, safeguards need to be included to guard against elite capture.

5. CHARACTERIZATION OF ENVIRONMENTAL SERVICES

To this point in the paper, we have referred to environmental services in a relatively generic manner. It is the case, however, that the interactions of PES with property rights, collective action, and poverty reduction differ between types of environmental services. The nature of the environmental services will influence the scale and type of collective action needed, the bargaining power of smallholders, and the investment or reinvestment requirements, which in turn affect the ability of the poor to invest. Table 2 presents a characterization of watershed protection, biodiversity

conservation and carbon sequestration services according to key factors related to property rights and collective action.

Table 2--Characterization of environmental services by the ten factors affecting reward mechanisms

Factor	Carbon sequestration	Biodiversity	Watershed function
1. Legal restrictions / fixed costs of market development	Countries that have ratified the Kyoto protocol are eligible for the CDM, but need to harmonize with other domestic policies.	Highly variable across countries, depending on conservation and wildlife policies and programs.	Many countries are experimenting and enacting new water laws to facilitate.
2. Costs of excluding freeriders from benefit streams	The CDM facilitates this.	Very problematic, except for tourism.	Moderate.
3. Small demand for ES	Demand for the carbon sequestration under the Kyoto protocol amounts to about $1 billion per year in 2004/5. It appears likely to grow in the future.	In developing countries there is more concern with functional and ecotourism value of biodiversity than the existence value of particular species.	Growing due to water shortages and changes in settlement patterns.
4. Small number of ES buyers or sellers with large share of the market	Many buyers & intermediaries at global scale, segmented by concerns for smallholders. Normally a single buyer at the local scale.	Large number of tourists, but otherwise limited.	Generally mediated through hydro-electric or municipal water supply agencies.
5. Transaction costs of market function / market entry / validation	High but clear under CDM at present time.	High but clear for tourism. Uncertain otherwise.	Uncertain.
6. Thresholds & increasing returns to effort in ES supply	Linear, relatively observable, with risks associated with permanence	Non-linear, with important thresholds, uncertainty about the function of complex ecosystems	Non-linear with important scale effects and high uncertainty in cause – effect relations

Table 2--Characterization of environmental services by the ten factors affecting reward mechanisms (continued)

7. Spatial specificity in ES supply	Source matters little in competitive markets, but more in voluntary markets where demanders are seeking good public image through the mechanism. Smallholders manage the largest areas appropriate for Kyoto afforestation, with little differentiation among smallholders.	Smallholders are seen as major threat to wild biodiversity. Poor smallholders often reside in buffer zones. Some types of biodiversity conservation are more site specific than others. Higher value for sites that are more visible and accessible.	Supply limited to certain areas, but may be other more cost-effective ways to achieve the same service. Public agencies are major alternative sources of supply, particularly in hotspot areas such as riparian areas, hillsides and wetlands.
8. Time path of ES production as a result of land use choices	Produced slowly over time and needs to be maintained indefinitely	Produces current and future values, which depend on relative scarcity	Produces current and future values, which depend upon downstream exposure to risks
9. Key partner resources for ES supply	Land, trees	Land in areas with high value for biodiversity conservation.	Land in riverine areas, water, vegetation in riverine and hillside areas, wetlands
10. Time path of ES rewards	Buyers prefer one-time payments with long-term assurance	Mixture of one-time and recurrent payments	Mostly recurrent payments associated with water use

While there will clearly be differences from site to site even within a broad category of ES, this analysis can help to identify key tendencies:

Because of the long time frame of carbon sequestration and the preference for one-time payments, secure property rights over land resources are likely to be very important for carbon PES mechanisms. However, this can be a two-way relationship: land rights being required as a condition for participating in PES, but secure tenure also being a potential incentive mechanism for ES in itself. Because both the land and tree resources are relatively immobile, defining property rights is easier than is the case when the key resources are mobile or fluctuating. The linear and observable nature of carbon sequestration means that collective action is not required for provision, though it can reduce transaction costs for payment. And although smallholders are very appropriate

suppliers of carbon sequestration, the lack of differentiation among suppliers means that any purchasers can go to many alternative suppliers; hence the bargaining power of any particular smallholder or group is likely to be low.

As complex as creating PES for carbon sequestration may be, the challenges are even greater for biodiversity. The fluctuating nature of the genetic resources (particularly animals, but also plants), the generation of current and future values, and the need for recurrent investment leads to a combination of one-time and recurrent payments, so long-term property rights over land are not as essential; rewarding tenants might be just as important as rewarding land owners. On the other hand, because of important threshold effects, collective action is likely to be much more important than for provision than in the case of carbon. Smallholders occupy many of the global biodiversity hotspots, but this does not automatically give them bargaining power. In many cases smallholders' livelihoods are perceived as in conflict with biodiversity, and public agencies are an alternative supplier. Thus in some cases, e.g. the CAMPFIRE program in Zimbabwe, poor people have been able to benefit from biodiversity conservation, but in many other cases they have lost access to land and livelihoods through eviction and creation of protected areas.

Like biodiversity, watershed functions produce current and fluctuating future values. While land is certainly a key resource, the vegetation and water itself play a key role, and these fluctuate considerably. This combination of factors often leads to a recurrent payments, which means that long-term property rights over land may not be as essential as decision-making rights over the land, vegetation, and water flows. The supply of watershed ES is non-linear; there are important scale effects, but also

differentiation in the importance of different types of land within a watershed. Thus collective action is important, but not all land or farmers are equally important. Certain areas like streambanks, steep hillsides, and wetlands may be more important than other areas. Nor do all watersheds generate equal value; those upstream of major cities, industries, hydroelectric facilities or other critical water users are more likely to receive attention. Smallholders may be able to benefit from watershed PES if they live in such critical areas, but public agencies are important alternative sources of supply, and regulation is more common than rewards.

6. CONCLUSIONS

Demand for environmental services will continue to grow, especially for carbon sequestration and water quality services in highly populated catchments. Attempts by the state to meet this demand through regulatory approaches and excluding users from upland watersheds, forests, and biodiversity hotspots have demonstrated their limitations, both in terms of effectiveness in delivering the resource and the high human welfare costs of the "fines and fences" approaches. Whether this increasing demand will be met by increasing supply from smallholders depends largely on the design of appropriate institutions.

Compensating land users for delivering environmental services off-site is a promising approach for protecting natural resources. It offers improvements over past command and control systems, which created enmity between local people and the authorities without achieving great success. There is also a great deal of interest in such mechanisms as a way of supplementing the incomes or enhancing the welfare of poor

land users. However, emerging experience suggests that there are several major challenges that limit the ability of smallholders to benefit from PES mechanisms.

This paper develops a conceptual framework to identify the conditions under which smallholders are likely to be able to participate in environmental service reward schemes. In particular, we maintain that greater consideration of the linkages between environmental service mechanisms and other rural institutions can lead to more equitable outcomes.

One important area of linkage relates to how collective action can be used to overcome transaction costs and barriers to participation in environmental service reward schemes by smallholders. Environmental service rewards will be viable as significant source of income for smallholders only if smallholders can be proven to be a large, effective and credible supplier of services. Currently, millions of smallholders sequester carbon, shelter biodiversity, and manage landscapes in ways that benefit downstream water users, but the costs of identifying such users, developing and enforcing contracts for specific environmental services means that they do not receive payments to provide incentives for them to sustain or enhance these environmental services. Realizing this potential requires successful pilot projects, generalizable design principles, cost-effective monitoring, and multi-disciplinary approaches to assessment.

Environmental service mechanisms in themselves represent the development of a new form of benefit stream, and the allocation of that benefit stream represents the emergence of a new kind of property rights. The vital question is whether this new form of rights will bypass the poor or enhance their livelihoods.

Linkages between environmental service reward mechanisms and property rights over the partner resources (especially land, water, and biodiversity), offer both constraints and opportunities for poor resource users to participate, depending on the institutional design. Identifying mechanisms through which managers of small private parcels, common property managers, and even resource users without state-recognized title to resources can be rewarded for environmental stewardship through environmental service rewards is critical for these reward mechanisms to enhance the welfare of poor resource-dependent communities. Although current mechanisms tend to require land ownership as a prerequisite to participate in reward schemes, the creation of new mechanisms for smallholder environmental services has the potential to generate more secure property rights and effective collective action to environmental services and partner resources (land, water, and genetic resources). Indonesia's HKm program, which offers secure land tenure to farmers as a reward for agreeing to beneficial land management practices, provides such a potential approach.

One of the greatest benefits of environmental service reward systems may lie not so much in the payments themselves, but in stimulating a change in attitude toward poor smallholders in environmentally sensitive areas: a shift from the state as protector to the smallholder as steward. An environmental service perspective requires understanding of spatial inter-relations, property rights to key resources, and the degree of consistency with social relations. A deeper understanding of the underlying differences in institutional, economical and social context between the various parts of the developing world is urgently needed, as direct extrapolation has not been successful.

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