Assessing the Potential for Payments for Watershed Services to Reduce Poverty in Highland Guatemala

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Abstract

It has often been assumed that payments for watershed services (PWS) would go mostly to poor land users, thus contributing to poverty reduction, but there has been little empirical verification to date. This paper uses data from highland Guatemala to assess the potential for PWS to reduce poverty by examining whether the recipients of payments for environmental services are likely to be poor. The watersheds in which PWS would be feasible due to the presence of downstream water users are mapped, and compared to maps of poverty rates and densities. Poverty rates vary substantially in areas where PWS could be developed. The total number of poor that could potentially be reached if PWS mechanisms were developed in all the water supply areas is 1.76 million, or 34 percent of the country's poor (excluding Petén).

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Keywords

Payments for environmental services (PES), mapping, environmental services, watershed, poverty, Guatemala

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Cover photo

Agricultural area in the Guatemalan highlands (Stefano Pagiola).
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Introduction

Payments for Environmental Services (PES) have come into increasing use as a conservation instrument in developing countries, particularly in Latin America (Landell-Mills and Porras, 2002; Pagiola and others, 2002a; Pagiola and Platais, 2007; Wunder, 2005; Wunder and others, 2008). PES programs seek to capture part of the benefits derived from environmental services (such as clean water) and channel them to natural resource managers who generate these services, thus increasing their incentive to conserve them. Many have assumed that these payments would go mostly to poor land users, and thus contribute to poverty reduction (Kerr, 2002; Landell-Mills and Porras, 2002; Pagiola and others, 2002; Grieg-Gran and others, 2005; Pagiola and others, 2005; Ravnborg and others, 2007). There has been little empirical verification of this assumption to date, however. In this paper, we assess the potential for PES to reduce poverty by examining whether the recipients of payments for environmental services are likely to be poor.

Because most land users in upper watersheds and other marginal areas are thought to be poor, and because most environmental services are thought to come from such areas, it is natural to assume that most PES recipients would be poor. We use data from highland Guatemala to examine this assumed close spatial correlation between areas of high poverty and areas that provide environmental services. We first identify specific watersheds in which PES mechanisms could potentially be developed, based on the presence of significant downstream water uses such as hydroelectric power (HEP) generation, domestic water supply, and irrigation. Conservation payments from water users will only be received by land users in watersheds that provide water to those users. We then compare these areas with the spatial distribution of poverty in the country, allowing us to ask two questions that are central to the likely impact of PES on poverty. First, how many of the potential providers of water services are poor? The local poverty impact of a particular PES mechanism on poverty will depend on whether potential providers are poor or not. Second, how many of the poor are potential water service providers? Even if most potential PES recipients are poor, it may be that few of the poor are potential PES recipients. The potential impact of PES on poverty at a national scale will depend on whether many of the poor are in fact in areas where PES mechanisms might be implemented. To our knowledge, this is the first effort to systematically assess the potential for PES and compare it to poverty levels at a countrywide scale.

Our focus in this paper is on PES for water services, which constitutes the most common form of PES program, and one with substantial potential for future growth (Pagiola and Platais, 2007). We shall use the term payments for water services (PWS) to distinguish such programs from PES programs more generally.
Payments for Environmental Services

The PES approach is aimed at addressing the classic problem of environmental externalities. Land uses can provide a variety of environmental services ranging from the regulation of hydrological flows to biodiversity conservation and carbon sequestration. However, land users typically receive no compensation for the environmental services they generate for others. As a result, they lack incentives to provide these services, which will tend to be under-provided. The PES approach seeks to address this problem directly, by establishing a mechanism through which service users can compensate land users that provide the desired service, or that adopt land uses that are thought to provide it (Pagiola and Platais, 2007; Wunder, 2005). Payments for Environmental Services are a market-based instrument to improve the provision of indirect environmental services in which service users pay service providers to provide a well-defined service (or land use that provides it) in a conditional and voluntary transaction. The PES approach is attractive in that it (i) generates new financing, which would not otherwise be available for conservation; (ii) is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of government or donor funding; and (iii) is likely to be efficient, in that it conserves services whose benefits exceed the cost of providing them, and does not conserve services when the opposite is true (Pagiola and Platais, 2007).

Interest in the use of PES has been especially high in Central and South America. Costa Rica and Mexico have the most elaborate PES programs, offering payments in large areas nationwide. Costa Rica’s Programa de Pago por Servicios Ambientales (PPSA) program pays land users to conserve forests, establish plantations, or adopt agroforestry practices (Pagiola, 2008). Mexico’s Pago por Servicios Ambientales Hidrológicos (PSAH) program pays forest communities to conserve forests (Muñoz and others, 2006). These two programs are unlike most other PES programs in Latin America, however, in that they are ‘government-financed’ or ‘supply-side’ PES programs (Pagiola and Platais, 2007; Engel and others, 2008) financed primarily by the countries’ governments rather than directly by service users—by allocating part of fuel tax revenues in the case of Costa Rica, and by allocating part of water fee revenues in the case of Mexico. Another large-scale government-financed PES program is found in China: the Sloping Land Conversion Program (SLCP, also known as ‘Grain for Green’) pays farmers to retire erosive agricultural land and reforest it (Bennett, 2008).

Other PES programs have been developed at a local scale, usually in specific watersheds, with financing from service users. In Ecuador, Quito’s water utility and electric power company pay to conserve the watersheds from which they draw their water (Echavarría, 2002a). In Costa Rica, the public service utility of Heredia pays for watershed conservation with funds from a special fee on consumers (Barrantes and

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1 Some use the term PES much more generally, to refer to any market-based instrument, or indeed any mechanism that provides an incentive for conservation. We use the term here much more narrowly, and our conclusions as to the possible links to poverty only apply to this specific instrument.
Gámez, 2007). Many small towns have similar schemes, including Pimampiro, Ecuador (Wunder and Albán, 2008); San Francisco de Menéndez, El Salvador (Herrador and others, 2002); and Jesús de Otoro, Honduras (Mejía and Barrantes, 2003). Hydroelectric power producers in Costa Rica (Pagiola, 2008) and Venezuela (World Bank, 2007), are also paying to conserve their watersheds, as are irrigation systems in the Cauca Valley of Colombia (Echavarría, 2002b).

As these examples indicate, use of PES has been focused primarily on water services—explicitly so in the case of most locally funded PES mechanisms, where water users have been the primary, if not the sole source of funding. Among the national programs, Mexico’s PSAH Program (as its name implies) focuses on water services (other, smaller programs pay for land uses designed to preserve biodiversity or sequester carbon). Costa Rica’s PSA Program formally tries to generate four services: water, biodiversity, carbon, and scenic beauty. However, water services are becoming increasingly important in the PSA Program because of the introduction of additional funding from a water tariff. As noted, in this paper we shall refer to PES programs that focus on water as PWS.

A few PES projects have focused on biodiversity, almost always with funding from outside the country—usually from the Global Environment Facility (GEF) or from conservation NGOs such as Conservation International, The Nature Conservancy (TNC), or the Worldwide Fund for Nature (WWF). A major limitation of most such funding is that it is generally only short-term.

There are also a growing number of projects that focus on carbon sequestration, buyers who need to buy carbon credits to meet commitments under the Kyoto Protocol’s Clean Development Mechanism (CDM) or national laws (World Bank, 2008). In Latin America, the World Bank’s BioCarbon Fund, for example, has signed Emission Reduction Purchase Agreements (ERPAs) with projects in Colombia, Costa Rica, Honduras, and Nicaragua. The potential for land-use based carbon sequestration under the CDM is limited, however, by restrictive rules on eligibility and by low overall ceilings on the amount of emissions credits that can be generated in this manner. There have also been projects that sell carbon sequestration services to the voluntary (or ‘retail’) market, which is much less restricted, but is also smaller and tends to pay less (World Bank, 2008).

**PES and poverty**

The PES approach was conceptualized and undertaken as a mechanism to improve the efficiency of natural resource management, and not as a mechanism for poverty reduction. However, many proponents have argued that PES can also have positive impacts on poverty (Landell-Mills and Porras, 2002; Pagiola and others, 2002a). Pagiola and others (2005) examined the main linkages that have been hypothesized to exist between PES and poverty. They identify three key questions: (1) Who are the actual and potential participants in PES programs, and how many of them are poor? (2) Are poorer households able to participate in PES programs? And (3) are poor households affected indirectly by PES programs? In this paper, we focus on the first of these questions.
Because environmental services tend to be site-specific, PES programs are almost invariably spatially targeted. In particular, because of their focus on water services, PWS programs are usually targeted to areas that are important for water supply. Mexico’s PSAH program, for example, based its definition of eligible areas on areas located in the recharge area of overexploited aquifers, in watersheds with high water scarcity, or in areas with high flood risk (Muñoz and others, 2006). Costa Rica’s PPSA program has hitherto been targeted primarily based on biodiversity considerations, although agreements with individual water users have resulted in specific watersheds being targeted for conservation (Pagiola, 2008). The introduction of the water tariff is making water services more prominent among targeting criteria. A quarter of the revenue from the water tariff is earmarked for use in the PSA program, and this revenue must be used in the same watershed in which it has been generated (Pagiola, 2008). Small-scale PWS mechanisms are almost all limited to the specific watersheds supplying water to the users providing financing.

The main mechanism by which PWS programs are assumed to contribute to poverty reduction is through the payments they make, which are thought to go mainly to poor land users. This hypothesized impact depends on the presumption that the land users in upper watersheds who would be recipients of PWS payments would tend to be among the poorer members of society. It has long been argued that land users in marginal areas such as the steep slopes of upper watersheds tend to be poor (CGIAR, 1997; Heath and Binswanger, 1996). Nelson and Chomitz (2007) refer to this hypothesized link between poverty, environmental degradation, and hydrological impact as the ‘forest-hydrology-poverty nexus’.

In Guatemala, Nelson and Chomitz (2007) find that the most hydrologically sensitive watersheds (defined as watersheds in which the interface between agriculture and forest is found on slopes of 8 percent or more and represents a significant proportion of the watershed’s area) also tend to have the highest concentration of poverty. The 77 most sensitive watersheds had a poverty rate of 70 percent and included a third of the country’s poor. They find a similar result in Honduras, although the relationship there is less pronounced.

Although these findings are tantalizing, they do not take into account the extent to which watersheds provide services. First, some hydrologically sensitive watersheds may not have potential for being included in a PWS program as they may have very few downstream water users. Second, the role of PWS is not limited to avoiding deforestation so as to avoid further loss of ecosystem services. It may also include restoration of ecosystem services in watersheds where they have already been lost or degraded. Indeed, these longer-settled watersheds may be more important from a water service perspective because of their greater concentration of population and other water users. These watersheds, however, may have much lower concentrations of poor inhabitants. Thus in Costa Rica’s densely populated Cordillera Volcanica Central area, many landowners are relatively well-off urban dwellers. As a result, a large proportion of participants in Costa Rica’s PPSA program in this area were found to be urban dwellers with substantial non-agricultural income (Ortiz and others, 2003; Miranda and others, 2003).
Our focus here is on watershed-scale PES mechanisms in which service users make payments to providers. PES programs that are financed by the government rather than users, such as the national-scale programs in Costa Rica and Mexico, are able to—and often required to—specifically address poverty and other social criteria. Thus, the delineation of eligible areas in Costa Rica’s PPSA program is based, in part, on an explicit poverty criterion. This is possible because the bulk of its funding comes from a fuel tax. Likewise, Mexico’s PSAH program, which is financed by a share of the revenue from water fees, gives additional points to applications from poorer ejidos, thus increasing their chance of being accepted and receiving payments. The vast majority of PES mechanisms, however, are local—typically at the scale of a watershed. Funding generated specifically from service users is all explicitly targeted to meeting service user needs. Within this context, poverty objectives can be addressed only indirectly.

There is a clear need, therefore, to have a better sense of who the potential participants are. As PWS programs are tied to areas with substantial downstream benefits, they cannot be targeted to areas of high poverty. The composition and structure of the population in the upper watershed will matter both to the success of the PWS program itself and for its impact on poverty levels.

In this paper, we extend the work of Nelson and Chomitz (2007) by explicitly examining watersheds that are important for water service provision, and so have significant potential for development of PWS mechanisms. We then examine both the poverty rate and the poverty density in these watersheds.

**Mapping areas that provide water services**

Mapping the areas that supply water services links the supply and demand of services in a spatially explicit way, allowing us to identify and prioritize areas with potential for PWS implementation. We mapped the areas that provide water services (‘water supply areas’) first by identifying the location of the intakes from which users obtain their water. We then delineated the portions of the watershed that contribute to those intakes using the closest 100m contour line up to the limit of the watershed, based on the principle that ‘water flows downhill’.

We use the watershed map of Guatemala developed by Nelson and Chomitz (2007) to ensure comparability with the poverty map they prepared (see below). They generated a 100-meter hydrologically correct elevation surface by interpolating contour lines and spot heights in combination data on rivers and lakes.

We focus on the larger, formal sector water users. There is also a considerable amount of direct use of water by rural households. Transaction costs make it impractical in most cases to base PWS mechanisms on such dispersed users. We focus

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2 See Pagiola and others (2007a) for additional details.

3 This map differs slightly from the watershed map produced by the Ministry of Agriculture, Livestock, and Nutrition (MAGA), but the differences are too small to materially affect the results of this analysis. Neither the MAGA map nor Nelson and Chomitz’s (2007) map would be detailed enough to allow planning of specific mechanisms.
solely on users of surface water, as groundwater flows are insufficiently understood to allow the recharge areas of specific wells to be mapped with confidence. We limited our analysis to the highland areas of Guatemala, omitting the northern Petén department. Petén accounts for about a third of Guatemala’s land area, but only 3 percent of its population and 4 percent of the poor.

For each user, we also collected information on the nature and magnitude of their water use. This information allows us to construct indices of the relative importance or “value” of water supply areas. At present these indices are use-specific, due to the very different nature of the uses. These indices give a broad sense of the extent to which payments might be made.

**Hydroelectric power producers**

HEP producers have a high potential for PWS because of the vulnerability of their activities to sedimentation and lack of water. Indeed, HEP producers are well represented in current PWS mechanisms. In Costa Rica, for example, many public-sector and private sector HEP producers are paying for conservation of the watersheds from which they draw their water through the country’s PSA Program, generating payments of about US$0.5 million and conserving about 18,000 ha annually (Pagiola, 2008). Other HEP producers have arranged bilateral payment deals with landowners (Rojas and Aylward, 2002). In Venezuela, power company CVG-Edelca will be paying 0.6 percent of its revenue (about US$2 million annually) to conserve the watershed of the Río Caroní, where 70 percent of the country’s HEP is generated (World Bank, 2007).

HEP producers are the easiest water users to map, as their location and installed generating capacity is well documented (Figure 1A). Moreover, the number of such users is small. The shading in Figure 1A reflects the importance of each water supply area, in terms of installed generating capacity per hectare. It is interesting to note that the highest value areas are not those in the watershed with the largest HEP plant, but rather in watersheds with medium-sized plants. Because of its large size (545,000 ha), the water supply area serving the largest HEP plant (Chixoy, 300MW) has a value index of only 0.55KW/ha. The highest-value water supply area, at 3.45KW/ha, is the 13,100 ha upper watershed of Río Las Vacas, which provides water to the 45MW Las Vacas plant.

**Domestic water supply systems**

Domestic water supply systems have also been frequent participants in PES mechanisms in Latin America. Urban areas that are paying to conserve their water supply areas range from large cities like Quito, Ecuador (Echevarría, 2002a), to mid-size towns like Heredia, Costa Rica (Barrantes and Gámez, 2007), and to poor rural townships like Pimampiro, Ecuador (Wunder and Albán, 2008).
Figure 1: Water supply areas for principal surface water users
There are large number of domestic water supply systems in Guatemala, with as much as 70 percent of households having access to piped water (World Bank, 2004). These systems are operated by a wide variety of agencies, as Guatemala is the only Central American country that does not have a national public corporation that manages domestic water supply in most urban areas (Walker and Velásquez, 1999). The domestic water supply sector is comprised of three components: (a) service to the Guatemala City metropolitan area, provided mainly by the Municipal Water Firm of Guatemala City (Empresa Municipal de Agua de Guatemala, EMPAGUA); (b) other urban areas, served by municipal governments, either directly or through public corporations; and (c) rural areas served by Community Based Organizations (Foster and Araujo, 2004). This study focuses on urban water supply systems that serve 1,000 household and more, mainly due to data availability constraints. Data on the location of water intakes were obtained by contacting EMPAGUA and municipal governments directly. Usable data were obtained for EMPAGUA and for 47 municipal water supply systems.

The water supply areas serving domestic water supply systems are shown in Figure 1B. In comparison to water supply areas serving HEP plants, which average about 70,000 ha, the water supply areas serving domestic water supply systems tend to be small, with an average size of less than 11,000 ha (Table 1 below). On average, these water supply areas serve 1.08 households per hectare. The water supply areas serving EMPAGUA are even smaller, with a mean size of 4,100 ha, but their value is much greater, as they serve 11.53 households per hectare on average.

**Irrigation**

Irrigation systems have been among the earliest to make direct payments for watershed conservation, in Colombia’s Cauca Valley (Echevarría, 2002). In general, however, they are very poorly represented among current PES mechanisms.

Guatemala has a relatively small irrigated area of 130,000 ha (FAO, 2007) divided into private, state, and small-scale ‘minirriego’ systems. Documentation of water withdrawal and intake location of irrigation systems was even more limited than for domestic water supply. We focus on larger systems, with a minimum of 500 ha under irrigation. As with municipal water systems, most information was obtained by contacting water users directly. Here, too, only approximate information could be obtained.

The water supply areas serving large irrigation systems are shown in Figure 1C. These areas vary widely in size, with an average area of about 64,000 ha (Table 1 below). On average, these water supply areas serve 0.14 ha of irrigated area per upstream hectare. Again, the most important water supply areas are not necessarily those that serve the largest irrigated areas.

**Other water users**

Industrial users have also been participants of PWS programs. For example, bottler Florida Ice & Farm is paying for watershed protection in Costa Rica (Pagiola, 2008). In Guatemala, the use of water by industrial users is very poorly documented. Moreover, these users proved very resistant to attempts to gather information.
Because of this, we were only able to gather data on a small proportion of all users, primarily coffee mills. The water supply areas (see Figure 1D) serving these mills have an average area of about 21,000 ha (Table 1). Their mean value in terms of production is 37.6 quintals (qq) per hectare.\(^4\)

**Summary**

We identified about 1.9 million ha in highland Guatemala with significant potential for development of PES mechanisms due to the presence of significant downstream water uses. This area is under-estimated in that data could only be obtained for a subset of all users. In addition, our analysis does not include relatively smaller users, who can undertake PES mechanisms on small scale. For example, several small communities along the edge of the Pico Bonito National Park in Honduras are paying to conserve their water sources (EcoLogic, 2006). On the other hand, the area of PWS potential over-estimates the area in which PWS mechanisms could actually be implemented. Water users may only be interested in paying for the services if there is an actual or perceived threat and if cost of payment is smaller than the cost of alternatives solutions. Furthermore, institutional constraints (such as insecure land tenure and collective action problems among service users) and technical constraints (such as the lack of monitoring) could also pose obstacles to the establishment of PWS programs in many cases.

**Mapping poverty**

With about 56 percent of its population under the poverty line, Guatemala has one of the highest poverty rates in Central America (World Bank, 2004). Poverty is predominantly rural and extreme poverty is almost exclusively rural, with over 81 percent of the poor living in rural areas. Poverty is a national problem, with relatively high levels throughout the country, but with pockets of particularly high poverty. A ‘poverty belt’ runs through the northern and northwestern regions.

We use the watershed-level poverty map for Guatemala developed by Nelson and Chomitz (2007), based on a poverty map developed by a team from the National Institute of Statistics (INE), the Presidencies’s General Planning Secretariat (SEGEPLAN), and the University of Rafael Landivar (URL), using the methodology developed by Poggi and others (1998). Essentially, the approach uses detailed data from small-sample household budget surveys from 1988-89 to obtain a predictive relationship of poverty rates, and then applies the relationship to municipio-level data (the highest available level of disaggregation) from the 1994 census to estimate spatially-specific poverty rates across the country. Similar approach have been applied in many countries (Bedi and others, 2007, compile examples from 12 countries). Nelson and Chomitz allocated population from this municipio-level map to the watershed map they had developed (see above). Where watershed boundaries intersected municipio boundaries, population was pro-rated to each watershed assuming a uniform population density.

\(^4\) 1 quintal (qq) is equivalent to 45.45 kilograms or 100 lbs.
A: Poverty incidence in highland Guatemala

B: Poverty density in highland Guatemala

Figure 2: Spatial distribution of poverty in highland Guatemala
Figure 2 shows the resulting watershed poverty maps for highland Guatemala. The top panel shows poverty incidence: the proportion of the population in the watershed whose income is below the poverty line. The bottom panel shows poverty density: the number of poor people per hectare. These maps show that poverty is a national problem in Guatemala, with relatively high poverty rates in many areas, especially the northern and northwestern regions. Areas of high poverty incidence are spatially autocorrelated, as are areas of high poverty density.\(^5\) However, areas with high poverty rates are not necessarily areas of high poverty density, and vice versa.\(^6\) Previous efforts to map poverty have found similar results. Areas with high poverty rates often have low population density, and thus a small absolute number of poor people. Poverty density is often highest in or near urban areas, but the concentration of better-off households in these areas means that poverty rates tend to be lower.

Two weaknesses of this approach need to be highlighted. First, conversion of the municipio-level poverty map to watersheds assumes that both population density and poverty rates are uniform across the municipio. If people are concentrated in flatter areas, the population of watersheds with steep slopes will tend to be over-estimated. Conversely, if most better-off people live in flatter areas, the poverty rates in such areas will tend to be under-estimated. These weaknesses were already present in the original watershed poverty map, but are magnified in our analysis as we focus on portions of each watershed. As such, we are unable to look into within-watershed variations in poverty between water supply areas and non-water supply areas. Second, the information available does not allow us to distinguish landless households. This is an important limitation, as PWS payments are payments to land users. In Guatemala, about 54 percent of the rural population are landowners, 19 percent are tenants, and 27 percent are landless. Among the rural poor, 59 percent are landowners, 20 percent are tenants, and 21 percent are landless (World Bank, 2004). It seems likely that the landless poor will tend to cluster in areas with reasonable potential for employment, either in agriculture or in other sectors. These would seem unlikely to be found in the upper parts of watersheds.

**Are potential service providers poor?**

The first question we examine is whether most potential participants in PWS mechanisms are poor. In Figure 2A, the map of water supply areas is compared to the map of poverty incidence in highland Guatemala. As can be seen, poverty rates in the water supply areas vary substantially. While some water supply areas have poverty rates as high as 97 percent, others have low poverty rates (Table 1). In general, water supply areas located in the north and northwest tend to have high poverty rates. The water supply areas for HEP have relatively high poverty rates of 67 percent on average, but with a very high variance. Poverty rates are lowest (29 percent) in the EMPAGUA water supply areas, because of their proximity to the Guatemala City metropolitan area.

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\(^5\) Moran’s index of spatial autocorrelation is I=0.35 for poverty incidence and I=0.29 for poverty density. Both are significantly different from zero at the 0.01 level.

\(^6\) Pearson’s product-moment coefficient between poverty rate and poverty density is only 0.11, indicating a week positive correlation.
Table 1: Poverty incidence and density in water supply areas

<table>
<thead>
<tr>
<th>Type of water user</th>
<th>Mean size (ha)</th>
<th>Poverty rate (%)</th>
<th>Poverty density (poor/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>HEP producers</td>
<td>70,000</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>(141,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic water supply</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Municipal systems</td>
<td>11,000</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td>(16,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMPAGUA systems</td>
<td>4,100</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>(4,800)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Irrigation systems</td>
<td>64,000</td>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>(73,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial users</td>
<td>21,000</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>(36,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All water supply areas</td>
<td>62</td>
<td>0</td>
<td>97</td>
</tr>
<tr>
<td>(21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entire country (except Petén)</td>
<td>65</td>
<td>0</td>
<td>98</td>
</tr>
<tr>
<td>(19)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Standard deviation in parentheses.

Figure 3 shows the distribution of watersheds with water supply areas according to their poverty rates. As can be seen, most watersheds have relatively high poverty rates. Over a quarter have poverty rates above 80 percent and almost 50 percent have poverty rates above 70 percent. The overall average poverty rate in water supply areas is only 44 percent (total number of poor in water supply areas, 1.76 million, divided by total number of people living in water supply areas, 3.97 million), however, which is lower than the national average of 53 percent (Petén excluded).

All water supply areas are not equivalent. Some have substantial potential for PWS because of the importance of downstream water uses, while others have limited potential. Figure 4 plots poverty rates in the water supply areas against indicators of the importance of the areas. These plots indicate that there is essentially no correlation between the importance of a water supply area and the poverty rate of people living there. Some areas with very high value have high poverty rates (for example, the water supply area of the Santa Maria and Canadá HEP plants, which generates 0.64 KW/ha, has an average poverty rate of 67 percent), while others have much lower poverty rates (for example, the water supply area of the Jurun Marinal and El Salto plants, which generates 0.85 KW/ha, has an average poverty rate of less than 1 percent).

There are also missing values of poverty for watersheds that are mostly scattered along the coastline.
Figure 3: Distribution of watersheds that contain water supply areas according to their poverty rates

Figure 4: Relationship between poverty rate and importance of water supply areas
Figure 5: Poverty rate and water supply areas near Sierra de las Minas

The area of the Sierra de las Minas mountain range illustrates the divergence between the value of water use and poverty (Figure 5). To the south of the mountain range, the Motagua River valley has a large concentration of high-value water users, including several HEP plants (with more planned), large commercial irrigation systems, agro-industrial producers, and several bottlers (including Coca Cola, Pepsi Cola, and several beer and rum producers). These users draw their water either from surface sources flowing south from the Sierra de las Minas, or from groundwater fed from the same area. There is clearly substantial potential to develop PWS mechanisms in this area, although problems of collective action are likely to arise. Indeed, the WWF and a local NGO, the Foundation for the Defense of Nature (Fundación Defensores de la Naturaleza, FDN), are working to do this (WWF, 2006). Poverty rates

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**Water users**
- **KW/ha**
- **HEP**
- **hh/ha**
- **Irrig ha/ha**
- **qq/ha**
- **Coffee mills**

**Poverty rate**
- Missing value
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 0.86
in this area, however, are very low, so any payments are unlikely to be received by poor households (indeed, the primary objective of the Water Fund established by the WWF is to finance conservation activities in the Sierra de las Minas Biosphere Reserve, not to pay landholders to change land uses). Conversely, the northern slope of the Sierra, which drains to the Río Polochic, has very high poverty rates, being settled mainly by smallholder farmers belonging to indigenous groups. This area, however, has very low potential for PES as shown by our analysis (the only water user of any size is a coffee mill, which draws its water from a small water supply area).

**How many of the poor are potential service providers?**

We now turn to the question of the number of poor people who might potentially be reached by PWS. Figure 2B compares the water supply areas with the poverty density map of highland Guatemala. As in the case of poverty rates, the poverty density in water supply areas varies substantially, from almost 10 poor people per hectare, to none. The average number of poor people per hectare in water supply areas is about 1, being slightly higher in the water supply areas of domestic water supply systems and HEP producers, and slightly lower in those of irrigation systems and industrial users.

![Figure 5: Distribution of watersheds that contain water supply areas according to their poverty densities](image)

Figure 5 shows the number of watersheds in water supply areas according to their poverty density. The pattern is the opposite of that in Figure 3: most watersheds that contain water supply areas have low poverty density. Over a quarter of watersheds have less than 0.5 poor/ha, and almost two-thirds have less than 1 poor/ha. The average poverty density of 0.95 poor/ha in watersheds with water supply areas is slightly more than the average poverty density in the country (excluding Petén) of 0.75 poor/ha, but the difference is not significant at the 5 percent level.
Discussion

Our results do not support the commonly held image of most potential PES recipients as poor. The image holds true in some cases, but not all. While there certainly are many watersheds with potential for PWS with high poverty rates, there are also many such watersheds with very low poverty rates.

The total number of poor that could potentially be reached if PWS mechanisms were developed in all the water supply areas is 1.76 million, or 34 percent of the country’s poor (excluding Petén). This is, of course, an upper bound.

PWS are unlikely to be developed everywhere. In some cases, the potential damage to water services may be low, because of the nature of the watershed or of the water users’ infrastructure; alternatively, water users may have cost-effective engineering solutions to such problems. In others, collective action problems may impede the development of PWS mechanisms. Presumably water users would be most interested in establishing PWS mechanisms in high-value water supply areas; they would presumably also be willing to pay more to protect such areas. However, as was shown, poverty is not correlated with the value of the service provided by a given water supply area.

In some cases, targeting of PES programs may go beyond targeting individual watersheds to targeting specific areas within those watershed. Within a watershed, some lands may be particularly important from the perspective of generating the desired environmental services (for example, riparian lands often play an important role in preserving water quality, and steeper slopes in avoiding sedimentation). Which area is critical depends on the specific service being sought, and so may vary from case to case. If payments are targeted to such areas, poorer households will receive payments only to the extent that they have land within them. However, to date few PES programs have been targeted to this degree. Costa Rica’s PSA program, for example, only targets individual watersheds to a limited extent, and does not target specific areas within those watersheds (Pagiola, 2008). Most PES programs, including Costa Rica’s PSA program, are evolving towards more targeted approaches, so this issue will become more salient. In Mexico, the pilot PES program in the Coatepec watershed targets specific areas within the watershed (Muñoz and others, 2006).

As PWS are payments for land use, only landholders will be eligible. Poor households that are landless will by definition not be able to participate, no matter how PES is targeted. To date, few PES programs have been implemented in areas where land rental is common, so it is difficult to predict how participation might be

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8 The landless poor may experience indirect impacts through labor markets—benefitting if implementation of PWS mechanisms results in increased labor demand, or being harmed if it results in reduced demand. The potential for adverse effects through reduced labor demand is particularly significant in Guatemala, where many of the poor depend on agricultural employment (World Bank, 2004). However, the relatively small areas in which PWS might be employed mean that even if PWS-supported practices are less labor intensive the overall effect on labor markets will likely be small. Even in Costa Rica, with a relatively large area under PES contracts, a GCE analysis found very limited labor market impacts (Ross and others, 2007).
affected in such areas, and whether poorer households would be particularly affected.

Even in cases where PWS mechanisms emerge and poor households are eligible to participate because they manage land in target areas, other obstacles may arise. Pagiola and others (2005) point out that, even if they are eligible, poor households will only participate in a PWS mechanism if they are both interested and able to do so. They may not be interested, for example, if the payment offered is insufficient to compensate them for the opportunity cost of the foregone land uses. To the extent that poorer households have less land, they may use what they have more intensively, and thus have a higher opportunity cost of land than better-off households. Alternatively, if their land is less productive, they may have a lower opportunity cost and so be more interested in participating at a given payment levels. Perhaps more important, poorer households may be less able to participate. They may lack titles to their land, for example. If participation requires making up-front investments (for example, to reforest degraded areas), they may be less able to finance these investments.

In at least two cases, the results thus far are promising. Pagiola and others (2007b, 2008) found that poorer households were able to participate to a substantial degree in a PES program being implemented by the GEF-financed Regional Integrated Silvopastoral Ecosystem Management Project at sites in Colombia and Nicaragua—indeed, by some measures they participated to a greater extent than better-off households. This is a particularly promising result in that the Silvopastoral Project provides a strong test of the ability of poorer households to participate as it requires participants to make substantial and complex land use changes. Nevertheless, one should not jump to the sanguine conclusion that all poor farm households everywhere will always be able to participate in PES programs. Both PES programs and local conditions differ from case to case, and there may well be cases where otherwise eligible poor households may find it difficult or impossible to participate.

As Pagiola and other (2005) note, the extent to which poorer households are in fact able to participate in a given PWS mechanism depends on the specific characteristics of both the households and the PWS mechanisms. It is possible to design PWS mechanism so as to reduce obstacles to the participation of poorer households, but not all PWS mechanisms may make the effort to do so. In fact, some PWS mechanisms may actively avoid enrolling poorer households because of the higher transactions costs that may be involved. Wunder and Albán (2008), for example, note that the PROFAFOR program that pays landholders in Ecuador to reforest has introduced a minimum contract size of 50 ha.

In considering how to best design a PES program so as to improve its poverty impact, it is important not to fall into the trap of considering the program as being primarily a poverty reduction tool. Making poverty reduction objectives predominate is understandably attractive, but would prove ultimately self-defeating. PES programs will not be sustainable unless service recipients are satisfied that they are receiving the services they are paying for. Subordinating the objective of generating services to that of poverty reduction risks failing to deliver on the services, and thus undermining
the very basis of the program. Once service users cease paying, neither poverty reduction nor resource management objectives will be reached. Thus there are many things that PWS mechanisms cannot do, no matter how desirable they might be from a poverty reduction perspective. They cannot, for example, target their interventions to areas of high poverty, as these may not be the areas that generate the desired services. Within an area that generates services, they can try to design the payment mechanism so as to allow the poor to participate. PWS programs also cannot choose to promote particular land use practices solely on the basis of the poor being able to undertake them. But they can seek to provide support to poor land users, including technical assistance or access to inputs and credit, so that they can adopt the desired land use practices.

Participation is a threshold issue; anyone who does not participate is unlikely to benefit from a PWS mechanism. For poor households that do participate in a PWS program, the actual impact on their well-being will depend on how the payment offered compares to the cost of participation (the opportunity cost of the foregone land use, plus any out of pocket costs resulting from participation). This is an area in which empirical data is particularly scarce, as opportunity costs on individual holdings are very difficult to estimate. Whatever its amount, PWS payments may also be attractive to poorer households because they are fixed, as long as they comply with the terms of their contract. In contrast, other revenue sources they may have access to may well vary substantially based on factors completely outside the household’s control. Revenue from farming activities, for example, will depend on the weather and on market conditions. Having part of their income not affected by such factors may thus be very attractive to poorer households.

Conclusions

As an initial effort to compare potential for PES to poverty, the analysis is necessarily crude. Improvements are needed in both the mapping of water supply areas (primarily by filling gaps in the information available on many water users and delineating hydrologically correct water supply areas) and the spatial mapping of poverty (by increasing the resolution, improving mapping along watershed rather than administrative boundaries, and distinguishing land users from landless poor).

Maps of water supply areas such as those developed here can be useful tools in targeting efforts to develop PES mechanisms, by identifying the areas that supply services, and gauging the relative importance of each areas. Combining such maps with poverty maps can provide an additional targeting criterion, allowing governments and donors to prioritize areas where PES has the highest potential of both improving service provision and reducing poverty. It can also provide useful information on the issues that might arise in implementing a PES mechanism. Attempting to do so in an area with many poor people will face problems that may not arise in an area with relatively better off people.

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9 As participation in a PES program is voluntary, it is probably safe to assume that participants will be at least no worse off by joining than they would be by not joining. Were this not the case, they could simply decline to participate.
References


