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User Financing in a National Payments for Environmental Services Program

Costa Rican Hydropower

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User Financing in a National Payments for Environmental Services Program: Costa Rican Hydropower

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Abstract

National government-funded payments for environmental services (PES) programs often lack sustainable financing and fail to target payments to providers of important environmental services. In principle, these problems could be mitigated by replacing at least some government funding with direct contributions from individual environmental service users who have incentives to underwrite payments and who can ensure that they are targeted appropriately. We use original survey data and official statistics to analyze user financing in Costa Rica's renowned national PES program, focusing on the amounts and sources of such financing, the drivers of contributions by private hydroelectricity plants (the most important sources of user financing), and hydroelectric plant managers' perceptions of the PES program. We find that user financing from all sources supports less than three percent of the program's total payments to environmental service providers. In the private hydroelectric sector, not surprisingly, large plants tend to contribute while small ones do not. Beyond that, the weight of evidence suggests that improving relations with local communities and government regulators may be as important a motive for contributing to the PSA program as ensuring the provision of forest environmental services. These findings raise questions about the potential of user financing to improve the efficiency and financial sustainability of national PES programs.

Key Words: payments for environmental services, voluntary regulation, hydroelectricity, Costa Rica

JEL Classification Numbers: Q23, Q24, Q28

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1. Introduction

Payments for environmental services (PES)—cash transfers from users of environmental services to providers of these services conditional upon continued provision—are an increasingly popular environmental management tool.[1] More than 300 PES programs have been implemented worldwide (Pagiola and Platais 2002; Wunder et al. 2008). Most have a limited geographic scope and are financed directly by users of specific environmental services—for example, payments by downstream users of hydrological services to upstream land managers in a single watershed. However, a handful of programs have a national scope and are financed by the government acting on behalf of users of environmental services throughout the country. China, Costa Rica, Mexico, and South Africa have implemented such programs, and Brazil and Zimbabwe are planning them (Wunder 2005; Engle et al. 2008; Pagiola 2007).

Compared with more common user-financed initiatives, national government-financed PES programs have both advantages and disadvantages (Pagiola and Platais 2007; Mayrand and Paquin 2004; FAO 2003). The main advantage is economies of scale. PES programs entail significant transaction costs that stem from recruiting service providers, negotiating conditional contracts, and monitoring compliance. National programs are able to spread these costs over a large number of agents, facilitating PES

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[1] The term PES has been applied somewhat indiscriminately to a wide range of economic incentive policies including national park entrance fees and eco-certification (Engle et al. 2008). According to Wunder (2005), a payment for environmental services is defined as (i) a voluntary transaction where (ii) a well-defined environmental service (or a land use likely to secure that service) (iii) is being "bought" by a (minimum one) service buyer (iv) from a (minimum one) service provider (v) if and only if the service provider secures service provision (conditionality).

agreements that would otherwise be prohibitively costly. An important disadvantage is inefficiency. Because national governments are not direct users of environmental services, they generally do not have detailed local knowledge about the value, provision, and use of these services. In addition, they are swayed by political and bureaucratic interests. As a result, they often do a poor job of identifying providers of important environmental services, negotiating cost-effective contracts, and monitoring compliance. A second disadvantage of national PES programs is that they often lack sustainable long-term financing. They depend principally on national tax revenues and international assistance, which are vulnerable to changing political and macroeconomic conditions.

In theory, those problems could be mitigated by expanding what is typically a minor component of national PES programs: voluntary payments by individual users of specific environmental services to government administrators to underwrite PES contracts with providers of these services (e.g., contributions by breweries that depend on forest hydrological services to government administrators to underwrite PES contracts with upstream land managers). Such user financing could improve the efficiency of national PES programs in several ways. First, environmental service users that voluntarily contribute to the system could help identify the most important service providers. Second, volunteers' contributions to the program could shed light on the value of these services. Finally, volunteers would have clear incentives to help monitor compliance with PES contracts and would have the means to do so, given their proximity to the service providers. Improved efficiency aside, such a financing would help extend and diversify financing in a national program.

Nevertheless, it is not clear that voluntary user financing would actually confer those benefits. This is a type of voluntary regulatory program—that is, a program that provides incentives but not mandates for agents to protect the environment or conserve natural resources. Considerable research suggests that that firms and farms participate in such programs for reasons that may have little to do with their stated goals, including winning favor with regulators, consumers, and local communities (Lyon and Maxwell 2002; Khanna 2001). If environmental service users contribute to a national PES program for these reasons, then it is less clear that the efficiency benefits noted above will be achieved, although such contributions would certainly help diversify the program's funding base.

The best-known national government-financed PES system with a user-financed component is Costa Rica's Payments for Environmental Services (*Pagos por Servicios Ambientales*, PSA) program.[2] Initiated in 1997, this program pays land managers to conserve and restore forest cover. The lion's share of payment contracts are negotiated between land managers and the National Forest Finance Fund (*Fondo Nacional de Financiamento Forestal*, FONAFIFO), the government agency that administers the program. Funded by national fuel tax revenue and grants and loans from bilateral and multilateral donors, for the most part the program operates without direct input from users of environmental services. However, the program invites individual hydroelectric plants, breweries, irrigated farms, and other organizations that benefit from environmental services to pay FONAFIFO to negotiate contracts with the providers of these services. To date, more than two dozen entities have voluntarily contributed some US$17 million to FONAFIFO under these provisions. Although numerous studies have examined Costa Rica's PSA program, to our knowledge, only one has focused on this user-financed component.[3] We believe further study is needed to understand the potential benefits of user financing in national PES programs. Toward this end, we address three questions about the user financing in Costa Rica's PSA program:

i. How many and what types of environmental service users are participating?
ii. What factors are driving participation?
iii. In the view of environmental service users, how has the program performed?

To answer the first question, we use data on PSA program finances provided by FONAFIFO. To answer the remaining questions, we rely principally on an original 2008 survey of all but one of Costa Rica's private hydroelectricity plants. We focus on these plants for a several reasons. They constitute the plurality of participants in the user-financed component of the PSA program. In addition, some plants have participated in

[2] South Africa's Working for Water program also has an user-financed component (Turpie et al. 2008).

[3] Miranda et al. (2006) presents qualitative case studies of the first seven agreements between users of environmental services and FONAFIFO, compares and contrasts them, and considers the policy implications. By contrast, we focus principally on agreements with hydroelectric plants and use original quantitative and qualitative survey data to identify the characteristics of participants, their motives for participation, and their views on the performance of their PES arrangements.

the program and others have not, a variation that can help identify the drivers of participation. Moreover, the total number of plants is small enough that we have been able to conduct in-person interviews with virtually all of them. Finally, these plants are arguably less likely to be influenced mainly by political pressures than government-owned hydroelectric plants.

We find that direct user financing from all sources supports less than three percent of the program's total payments to environmental service providers. In the private hydroelectric sector, not surprisingly, large plants tend to contribute while small ones do not. Beyond that, the weight of evidence suggests that improving relations with local communities and government regulators may be as important a motive for contributing to the PSA program as ensuring the provision of forest environmental services. Despite generally positive views about its performance, some hydroelectric plants favor direct investment in watershed protection over voluntary contributions to the program. These findings raise questions about the potential of user financing to improve the efficiency and financial sustainability of national PES programs.

The remainder of the paper is organized as follows. The second section reviews literature on national PES programs and on the drivers of participation in voluntary environmental programs. The third section provides background on Costa Rica's PSA program and private hydroelectricity sector. The fourth, fifth, and sixth sections address the three focus questions listed above. The last section summarizes our findings and considers their policy implications.

2. Literature

The first part of this section reviews the empirical literature on national government-financed PES programs, focusing on the two weaknesses discussed above—inefficiency and unsustainable financing—and on the two national PES programs in developing countries that have been evaluated extensively: Costa Rica's PSA program and Mexico's Payment for Environmental Hydrological Services (*Pago de Servicios Ambientales Hidrológicos,* PSAH) program. The second part of this section reviews the literature on the drivers of participation in voluntary environmental programs.

2.1. National Government-Financed PES Programs

An emerging consensus suggests that both Costa Rica's PSA program and Mexico's PSAH program have done a poor job of targeting forested areas that provide

important environmental services and face a significant risk of deforestation. As discussed below, the main component of Costa Rica's PSA program provides annual payments to managers of forested lands conditional on their retaining forest cover and aims at ensuring continued provision of hydrological benefits and biodiversity among other environmental services. Yet as of 2005, only 35 percent of the land participating in the PSA program was in a watershed with downstream users of hydrological services and, depending on the definition of biodiversity priority areas, 30–65 percent of PSA land was in biodiversity priority areas (Pagiola 2008). Perhaps more important, virtually all rigorous statistical analyses based on forest cover data derived from satellite images find that the PSA program has done little to affect deforestation, largely because land at high risk of deforestation has not been volunteered into the program. Rather, the lion's share of land enrolled in the program has been ill-suited for agriculture, pasture, and other cleared land uses and very probably would have remained forested absent the program (Pfaff et al. 2008; Robalino et al. 2008; Arriagada et al. in press; Sills et al. forthcoming).[4,5] Wünscher et al. (2006, 2008), Hartshorn et al. (2005), and Sierra and Russman (2006) all find that the PSA program could benefit from improved targeting.

Mexico's PSAH program shares many of PSA's design elements, including a focus on forest conservation and voluntary enrollment. However, as it names suggests, the program aims specifically at ensuring the provision of hydrological benefits. Also, its administrators have made an effort to target high-benefit areas. Yet evaluations suggest that these efforts have been disappointing. In 2006, 51 percent of land enrolled in the program was in watersheds classified as "not overexploited" and 68 percent was deemed to have low or very low deforestation risk (Muñoz 2008; Alix-Garcia et al. 2005).

Concerns have also been raised about the sustainability of the financing for Costa Rica's PSA program and Mexico's PSAH program. As discussed below, Costa Rica's PSA program is financed by national fuel and water taxes and by grants and loans from bilateral and multilateral donors. However, these funds have not been nearly sufficient to enroll all the landowners who have applied to the program (Pagiola 2008). For example, in 2006, one of FONAFIFO's principal regional offices had enough funds to enroll only

[4] A second reason the program has had little impact on deforestation is that there has been little deforestation. Rates of clearing nationwide have dropped precipitously since the creation of the program in 1997 because of strict command-and-control regulations and declining returns to pasture (Pagiola 2008).

[5] An exception is Tattenbach (2006).

one-sixth of the hectares for which it received applications (Wünscher et al. 2008). Mexico's PSAH program is funded by a national water tax. According to Alix-Garcia (2005, 70), "This does probably not qualify as a sustainable financial arrangement since, though it has been written into law, it is decoupled from the intentions of the program and subject to the political process."

2.2. Voluntary Environmental Programs

The user-financed component of Costa Rica's PSA program is a type of voluntary environmental program. Empirical research on the drivers of participation in such programs suggests that pressures applied by regulators, markets, and communities drive participation, as does variation in transaction costs associated with joining these programs. The first type of pressure has probably attracted the most attention. Considerable research suggests that private parties participate in voluntary regulatory programs to preempt more stringent mandatory regulation or—particularly germane for our analysis—to obtain preferential treatment from regulators (Segerson and Miceli 1998; Maxwell et al. 2000). For example, anecdotal evidence about Project XL, the U.S. Environmental Protection Agency's flagship voluntary program during the 1990s, suggests that firms obtained significant production cost advantages from participation because EPA provided preferential "regulatory relief" (Marcus et al. 2002). Similarly, studies have found that U.S. firms that engage in voluntary abatement obtain regulatory permits more quickly than those that have not (Cothran 1993; Decker 2003).

Pressure brought to bear by consumers also motivates participation in voluntary environmental programs. Theory suggests that firms may voluntarily improve their environmental performance to attract "green" consumers (Arora and Gangopadhayay 1995). Some empirical evidence suggests that this logic applies to participation in voluntary programs (Vidovic and Khanna 2007; Videras and Alberini 2000).

Pressures generated by communities and nongovernmental organizations may also create incentives for firms to join voluntary programs. Such pressures are the focus of the literature on so-called informal regulation, which mostly consists of cross-sectional, plant-level econometric analyses of environmental performance in developing countries (see World Bank 1999 for a review). For example, in the early 1990s, pressures applied by industry and neighborhood organizations spurred participation in a voluntary clean fuels initiative targeting small brick kilns in Mexico (Blackman and Bannister 1998).

Finally, differences across firms in transaction costs associated with joining voluntary regulatory programs due to, among other things, difference in human capital may help explain participation (Delmas and Marcus 2004). For example, transaction costs associated with participating in Project XL averaged more than $450,000 per firm, varied considerably across firms, and deterred some firms from participating (Blackman and Mazurek 2001).

3. Background

3.1. Costa Rica's PSA Program

Costa Rica's program is one of the oldest and most extensive PES programs in existence and has been widely studied (Pagiola 2008; Pfaff et al. 2008; Rojas and Aylward 2003; Rodriguez 2005; Kosoy et al. 2007). Along with Costa Rica's extensive system of protected areas, it is a testament to the country's unusually strong commitment to forest conservation.

Costa Rica's policies have not always been so forest friendly, however. For example, the Forestry Act of 1969 (No. 4475) authorized subsidies for converting forest to pasture. It was not until the 1980s, in the wake of growing domestic and international concern over reports that Costa Rica's forest cover had shrunk to just over a quarter of its land area, that the government reversed course and began providing subsidies to encourage reforestation (for commercial timber production) and the conservation of existing forests (Pagiola 2008). The Forestry Act of 1996 (No. 7575) transformed this system of subsidies into national payments for an ecosystem services program and created FONAFIFO, a new, semiautonomous branch of the Ministry of Environment and Energy (*Ministerio de Ambiente y Energía*, MINAE) to manage the new program.[6] A major motive for creating the PSA program was to recast reforestation and conservation subsidies as payments for environmental services—namely biodiversity, carbon sequestration, scenic beauty, and hydrological benefits (Pagiola 2008). The Forestry Act of 1996 also prohibited conversion of forest to any other type of land use, a provision that

[6] When the PSA program first started, land managers' participation was solicited by SINCAC and by nongovernmental organizations, most notably the Foundation for the Development of the Central Range (*Fundación para el Desarrollo de la Cordillera Central*, FUNDECOR). In 2003, FONAFIFO took over this function (Pagiola 2008). In this paper we do not differentiate between FUNDECOR projects and those of FONAFIFO.

has significantly slowed deforestation but made disentangling the independent impact of the PSA program problematic.

Although the PSA initiative is not the only one involving payments for ecosystem services in Costa Rica, it is by far the largest.[7] It comprises 11 programs targeting different types of activities and land uses. In each program, a landowner receives annual payments to carry out specified practices, such as preserving existing forest cover or planting new trees. As of May 2008, these 11 programs were making payments on roughly 377,000 hectares, accounting for 7.4 percent of the land area of the country. By far the most important of the programs is Forest Protection, which accounts for 86 percent of the 377,000 hectares receiving FONAFIFO payments (Table 1). Two other programs—Reforestation and Forest Management—account for 9 percent and 4 percent of participation, respectively, and the remaining 8 programs account for 2 percent.[8]

Table 1. Percentage of all hectares receiving FONAFIFO payments (377,000 ha, total), by program and funding source, through May 2008

	Funding source				
Program	IBRD[a] & GEF[b]	KfW[c]	Ordinary budget	User financed[d]	All
Forest Protection	57	14	11	3	86
Reforestation	4	2	2	0	9
Forest Management	2	2	0	0	4
Others	1	0	1	0	2
All programs	65	18	13	3	100

[a]International Bank for Reconstruction and Development.
[b]Global Environment Fund.
[c]German International Development Bank (*Kreditanstalt für Wiederaufbau*).
[d]See Table 2 and discussion below.

Source: FONAFIFO 2008a.

The Forest Protection program requires landowners to preserve primary or secondary forest cover on their land for five years, a commitment that can be renewed. FONAFIFO makes a partial payment to the landowner when she signs a program

[7] The PES agreement between the La Esperanza hydroelectric plant and the Monteverde Conservation League does not involve FONAFIFO (Rojas and Aylward 2002).

[8] The remaining 2% included the agroforestry program, which pays landowners based on number of trees harvested rather than number of hectares enrolled.

contract. Subsequent payments are made only after a third party verifies that tree cover has not been cleared.[9] With a few minor exceptions, payments are the same everywhere in the country. They have increased over time partly to account for inflation. Annual per hectare payments were US$40 in 1997 when the PSA program was created, rose to US$43 in 2005, and to US$64 in 2006 (Pagiola 2008).

FONAFIFO's funding for payments to land managers has been derived from four types of sources (Table 1). National tax revenue—from a national tax on gasoline (3.5 percent of the total gasoline tax), supplemented since 2006 by revenue from a national tariff on water use (25 percent of the total tariff)—is the main continuing source of funds for this program. As seen in Table 1, however, to date, most of the hectares enrolled in the PSA program have been financed by other sources. Loans and grants from the International Bank for Reconstruction and Development and donations from the Global Environment Facility have financed payments for 65 percent of all hectares enrolled in FONAFIFO programs.[10] The German International Development Bank *(Kreditanstalt für Wiederaufbau)* has financed another 18 percent. FONAFIFO's ordinary budget has paid for 13 percent of all participating hectares. Finally, private voluntary contributions by beneficiaries of forest environmental services have financed FONAFIFO payments to 3

[9] Monitoring of compliance by landowners participating in the FONAFIFO program is the responsibility of MINAE and the National System of Protected Areas (*Sistema Nacional de Areas de Conservacion*, SINAC). Pagiola (2008) considers this monitoring system "strong" and calls the database used to track compliance "state-of-the-art." Monitoring records for at least some of the program's contracts can be accessed online (http://www.catie.ac.cr/BancoConocimiento/E/econofor_-_verificacion_csa/econofor_-_verificacion_csa.asp). Nonetheless, FONAFIFO's implementation has not always been prompt. Pagiola (2008, Table 1) reports that as of 2001, private contributions to protect 14,650 hectares had been made between 1997 and 2001, yet as of the end of 2004, contracts protecting only 10,175 hectares had actually been signed. Based on more recent data (Garcia 2008), it appears that the problem may even have gotten worse.

[10] A $32.6 million loan from the International Bank for Reconstruction and Development is to be repaid by FONAFIFO over a 12-year period starting in 2006.

percent of total hectares. The present paper focuses on this last portion: user-financed funding.[11,12]

FONAFIFO has offered users of hydrological environmental services three types of contractual arrangements for making contributions to fund payments for environmental services. The original arrangement was an ad hoc agreement in which both the number of hectares receiving payments and the amount paid per hectare were negotiated by FONANFIFO and the payee. Starting in 2003, FONAFIFO introduced a standard payment, a certificate of environmental service (*Certificado de Servicio Ambientale*, CSA) to facilitate relatively small contributions. A CSA covers the full cost of a payment for a single year for a single hectare. A CSA cost $43 in 2005 and $64 in 2007. Finally, the 2006 water law *(Canon de Agua)* dramatically raised water use tariffs and mandated that a quarter of the revenue from these tariffs be transferred to FONAFIFO to help finance PSA contracts. Under this law, individual water users can deduct from their tariff obligations any monies paid directly to FONAFIFO's PSA program. This provision purports to give water users more input into how and where FONAFIFO uses their funds from the tariff.

3.2. Costa Rica's Private Hydroelectric Sector

Although Costa Rican private hydroelectric plants have clear profit motives, their history suggests that regulation and politics also have considerable influence on their decisionmaking. The U.S.-based Electric Bond and Share Company was the first major producer in the country, operating as a monopoly (Quesada 2002). It was nationalized in

[11] Though we exclude them from this category, GEF grants used to support payments for environmental service could also be considered user financing, since the PSA program aims to preserve biodiversity, a global public good, and GEF purports to be biodiversity service users' agent. IBRD and GEF funding has been provided under two financing vehicles: the Ecomarkets Project (2001–2006) and the Mainstreaming Market Based Instruments for Environmental Management (MMBIEM) project (2007–present). Under the former, GEF provided US$8 million in financing, of which US$5 million was used to finance payments (and US$3 million for institutional strengthening); under the latter, GEF is providing US$10 million (Pagiola 2008).

[12] User financing was not an original feature of the PSA program, but soon after the program was created in 1996, FONAFIFO began to search for additional sources of funding. This effort quickly led to the hydroelectric sector, one of the most easily identified users of environmental services (Rodríguez 2005). With the assistance of FUNDECOR, the Costa Rican nongovernmental organization, FONAFIFO's first contacted Energía Global, then owner of the Volcan and Don Pedro hydroelectric plants (Chomitz et al. 1999). Discussions with FONAFIFO staff, along with information on the organization's website, suggest that soliciting user financing remains an important activity.

1928 and eventually evolved into the National Power and Light Company (*Compañia Nacional de Fuerza y Luz*, CNFL) and the Costa Rican Electric Institute (*Instituto Costarricense de Electricidad*, ICE), the two government-owned electric companies that produce and distribute the vast majority of Costa Rica's electricity.

Private energy producers, including regional energy cooperatives, have always operated alongside the public sector. Nonetheless, their legal status was ambiguous until a 1990 law that formalized their right to generate power and required them to sell all their output to ICE. This law spurred the construction of numerous small private plants during the 1990s. In recent years, electricity has been produced by 35 private plants, including wind, geothermal, and biomass plants (see Appendix). Twenty-four private hydroelectric plants owned by 18 firms were operating in 2007.

Private electricity generation in Costa Rica is highly contentious politically. The 1990 law that formally allowed private generation encountered stiff opposition for at least three reasons (Romero-Pérez 2004; Marchamalo and Romero 2007; Miranda et al. 2006). First, even small "run-of-the-river" hydroelectric plants have significant adverse environmental impacts, including reducing in-stream flows in a portion of the river, disturbing forest cover in construction sites, and damaging aquatic life, all of which can create tension with local communities. As a result, national environmental NGOs initially opposed private hydroelectricity. Second, leading politicians, including José María Figueres Olsen, then minister of agriculture and later president, invested heavily in new private generating plants, raising concerns about undue political influence on licensing and regulation (Romero-Pérez 2004). Finally, investors proposed building plants in indigenous reserves. Opposition to private hydroelectricity has severely restricted investment. From 1997 through early 2008, a de facto moratorium was placed on new water concessions needed for private hydroelectricity, effectively choking off the new investment.[13]

All electricity generated in Costa Rica must be sold to a government-owned monopsonistic buyer (ICE), and electricity prices are fixed by the Public Services Regulatory Authority (*Autoridad Reguladora de los Servicios Públicos*, ARESEP). For most plants, ARESEP's uses complicated pricing formulas tied to the long-term marginal

[13] In early 2008 President Oscar Arias Sánchez issued a decree authorizing MINAE to give water concessions to the private hydroelectric industry (Murillo 2008).

costs of production to ICE (ARESEP 2007, 2002). However, prices can vary significantly from one plant to the next.[14]

Conventional wisdom, including within the hydroelectric sector, holds that watershed protection benefits hydroelectric plants by regulating in-stream flow and reducing sedimentation. As one interviewee remarked, "The watershed is doing the work for you, it's part of the machine." For this reason, the hydroelectric sector was targeted early for participation in the PSA program. It is worth noting, however, that the scientific foundation for such benefits is relatively weak. Stadtmüller (1994, xi–xii) identifies several "myths" about the hydrological function of tropical rain forests. He states that compared with all but a few particularly inappropriate land uses, "tropical rain forests do not increase water yield." Similarly, Rojas and Aylward (2003, 79) conclude that the evidence for measurable watershed benefits from forest cover is slim, finding "a series of assumptions, invalid methodologies and erroneous results and conclusions being cited over and over again, all of which seemingly builds a basis on which further market development is based."

4. How Many and What Types of Environmental Service Users are Participating?

This section focuses on the number and type of environmental service users that have voluntarily contributed to the user-financed component of the PSA program. We first examine contributions from all sources, and then focus on contributions from private hydroelectric plants.

4.1. All Sources

According to FONAFIFO, as of 2007, just over US$17 million in payments for environmental services came from user financing (Table 2). These monies funded 3 percent of the hectares enrolled in the program (Table 1).[15] However, 55 percent of this

[14] Three types of contracts predominated in 2008. "Variable" contracts are fixed in dollars at a "theoretical" rate of $0.06 per kilowatt-hour, but vary in colones. The theoretical rate is that which a plant would be paid on average if it generated at full capacity for the entire year (Barrantes- Chaves 2008). "Fixed" contracts are paid based on an ARESEP formula that periodically adjusts to estimate the long-term marginal costs of production to ICE. Finally, two private plants (El General and La Joya) operate under "build-operate-and-transfer" contracts at prices that were bid for a fixed term, after which ownership of the plant is transferred to the government.

[15] This analysis is based on data provided by Garcia (2008).

$17 million was provided by a single nongovernmental organization: the Pax Natura Foundation, a Utah-based NGO that sells personal carbon credits and that has ties to the Costa Rican government.[16] Another 33 percent was contributed by Costa Rica's two public electric companies, CNFL and ICE. Finally, 3 percent was provided by the Centro Agronómico Tropical de Investigación y Enseñanza, a multilateral agricultural research and educational organization, but the funds originated with the World Bank. Excluding these four sources, 32 firms, organizations, and individuals have contributed a total $1.7 million, 10 percent of total user financing.

Table 2. User-financed contributions to FONAFIFO, 2003–2007

Type of donor	Amount (000 US$)	Percentage of total from all donors	Percentage of total from purely private sources[b]
NGO (Pax Natura)	9,675.4	55	---
Government-owned hydroelectric	5,762.9	33	---
Private hydroelectric	580.6	3	35
CATIE[a]/World Bank	441.0	3	---
Brewery	272.7	2	16
Carbon credits	215.7	1	13
Agriculture related	199.5	1	12
Hotel	126.8	1	8
Airline	85.7	0	5
Agricultural cooperative	75.0	0	4
Construction/cement	57.0	0	3
Hydroelectric cooperative	22.4	0	1
Tourism	14.9	0	1
Public utility	9.1	0	1
Plastics	8.6	0	1
Sports association	1.4	0	0
Personal association	1.1	0	0
Consulting/advertising	1.0	0	0
Personal	0.6	0	0
Total	17,551.4	100	100

[a]Center for Tropical Agricultural Research and Training (*Centro Agronómico Tropical de Investigación y Ensenañza*).
[b]Excludes funds from government-owned firms, multilateral sources, and the NGO Pax Natura.

Source: Authors' analysis of data from Garcia 2008.

[16] The current Costa Rican president, Oscar Arias, is honorary chair of Pax Natura (Pax Natura Foundation).

As noted above, the PSA program aims to ensure the provision of four forest environmental services: biodiversity, carbon sequestration, scenic beauty, and hydrological benefits. Although the agency's data do not indicate which services are being paid for when a user makes a contribution, in most cases this information can be inferred (Table 2). Hydrological benefits were almost certainly the principal concern of the private hydroelectric plants, the brewery, and the agricultural entities, which together represent more than 60 percent of the contributions from the 32 service users. The majority of the remaining contributions came from environmental service users seeking to offset carbon emissions.

4.2. Private Hydroelectric Sector

Between 1997 and 2007, private hydroelectric plants contributed US$580,000 to FONAFIFO. These funds represent 35 percent of all user financing from all sources excluding the four discussed above (Pax Natural, ICE, CNFL, and CATIE), the largest share of any economic sector (Table 2). The funds were contributed by five plants owned by four firms (Table 3). Hence, the majority of the private hydroelectric plants have not participated in FONAFIFO's program.

All contributions by the five participating private hydroelectric plants were to FONAFIFO's Forest Protection program. The contractual basis of the contributions differed. Four plants contributed via a negotiated payment. In most cases, they negotiated a per hectare contribution that was less than FONAFIFO's actual payment (on the grounds that they were paying only for hydrological benefits, one of the four environmental services provided by forests). In each case, FONAFIFO contributed the difference between the negotiated contribution and the actual payment. One plant purchased CSAs and one plant signed a bilateral agreement with a nongovernmental organization. Finally, three plants allocated 25 percent of their water tariff directly to FONAFIFO under provisions of the 2006 water law.

Table 3. Contracts signed between FONAFIFO and private hydroelectric plants, by type, 1997–2007

Firm, Plant	Year(s)	Hectares protected[b]	Contribution per year per hectare (US$)	Contribution per year (US$)
Negotiated agreements				
Energía Global,[a] Don Pedro	1997, 2002	1,000	12	12,000
Energía Global,[a] Volcán	1997, 2002	1,000	12	12,000
Matamoros, Platanar	1999	750	15/30[c]	22,500
Holcim, Aguas Zarcas	2005	1,666	30	49,980
CSAs				
Tuis, Tuis	2006	75	57	4,286
Direct payment of water tariff				
Enel,[a] Don Pedro	2007	10	64	620
Enel,[a] Rio Volcán	2007	11	64	716
Matamoros, Platanar	2007	24	64	1,528
Bilateral agreement with Monteverde Conservation League				
La Esperanza, La Esperanza	1998	3,000	10	30,000

[a]In 2001, Enel GreenPower, an Italian energy firm, purchased Energía Global, a Costa Rican firm (Business Wire 2001).
[b]Figures from FONAFIFO contract, actual hectares enrolled may differ.
[c]At the end of 2004, Platanar was paying US$15/ha for 284 hectares with land title (285 ha at end 2004) and US$30/ha 385 hectares without title.

Sources: Rojas and Aylward 2002; Garcia 2008; Pagiola 2008.

Private hydroelectric firms' contributions to FONAFIFO were a relatively small percentage of their revenues. For all firms except for La Esperanza, annual contributions constituted less than 1 percent of annual revenues (Table 4). For the two firms that were first to participate (Energía Global and Matamoros), contributions were roughly equivalent to the average revenue from a single day's of operation. Firms that contributed later gave substantially larger amounts, both in absolute terms and as a percentage of their annual revenue.

Table 4. Annual PSA payments as percentage of annual revenues

Firm, Plant(s)	Year of first agreement	Annual PSA contributions as percentage of average annual revenues[a]
Energía Global, Don Pedro and Volcán	1997	0.24
La Esperanza, La Esperanza	1998	1.91
Matamoros, Platanar	1999	0.29
Holcim, Aguas Zarcas	2005	0.94
Tuis, Tuis	2007	0.78
Average		0.81
Average excluding La Esperanza		0.56

[a]PSA expenditure data from Table 3 converted to 2000 dollars. Revenue data calculated using ARESEP 2008, converted to 2000 dollars, and averaged for all years from 1996 to 2007 for which plants operated a full year.

Source: Own calculation from data in Rojas and Aylward 2002, ARESEP 2008, and Garcia 2008.

5. What Factors Drive Participation in the Private Hydroelectric Sector?

To identify the drivers of private hydroelectric plants' participation in the PES program, we undertook two types of analyses. First, we asked plant owners and managers to identify the most important benefits of participation. Second, we compared average characteristics of program participants and nonparticipants to identify characteristics correlated with participation. Below, we discuss the data used for each analysis and then present results from each. We find that a desire to improve community and government relations was an important motive for participation, that participants tended to be large and/or to have characteristics associated with large plants, and tended to be located in lightly deforested watersheds with a relatively low proportion of land in protected areas.

5.1. Data

Between February and June 2008 we conducted in-person interviews with owners or managers of 17 of the 18 companies that owned the 26 active private hydroelectric plants in Costa Rica.[17] When a single firm owned two or more plants in the same

[17] See list of interviewees in the Appendix. In all but two cases, we interviewed the manager of the plant, and in five cases, the manager was also one of the plant's owners. We could not obtain an in-person interview with the manager of one firm and therefore conducted a telephone interview with a former manager who had been involved in the PES program; this interview did not cover all the questions asked of the other firms. Anonymity was guaranteed to all respondents.

watershed, we treated them as a single production unit.[18] The interviews were semistructured, including both open-ended and closed-ended questions about respondents' perceptions, plant and watershed characteristics, and contacts with FONAFIFO. Because the respondents were not able or willing to answer all our closed-ended questions, the number of responses varies by question. The interview data are supplemented by official statistics on plants' contributions to FONAFIFO, pricing, and revenues.[19]

We exclude three plants from the analysis because unusual institutional circumstances may have driven their decisions to participate or not participate. We exclude the La Esperanza plant (a PSA program participant) because its contract is unique in Costa Rica. It makes payments to a nongovernmental organization rather than FONAFIFO and perhaps more important, agreed to these payments to settle a land dispute (Rojas and Aylward 2003).[20] We also exclude the large La Joya and El General plants (nonparticipants) because they were developed and are operating under build-operate-and-transfer (BOT) contracts in which, after a defined period, plant ownership will be transferred to ICE. These contracts create incentives that differ from those for the remaining private hydroelectric plants.

5.2. Perceived Benefits of Participation

To shed light on the private hydroelectric plants' motives for participation in the PSA program, we asked our interviewees to rank the three most important benefits of participation on a list of possible benefits compiled in open-ended preliminary interviews. The list of possible benefits had seven items:

- forest protection and provision of environmental services;
- improved relations with local communities;
- improved political prospects at the national level;

[18] Three firms owned more than one plant in a single watershed: Enel (Don Pedro and Volcan plants); O&M Eléctrica Matamoros S.A. (Matamoros and Plantar plants) and Edificadora Beta (Caño Grande and HidroVenecia plants).

[19] Because prices are set by ARESEP and all output is sold to ICE, revenue data are publicly available.

[20] These factors may explain why the plant's contributions as a percentage of its revenues are so much higher than for all other plants.

- improved relations with other businesses;
- improved relations with government regulators;
- improved relations with ICE; and
- a catchall “other” category.

Table 5 presents results for all of our interviewees, and for subpopulations of participants and nonparticipants. Eighty percent of all interviewees chose “forest protection and provision environmental services” as the most important benefit of the program. The percentage was higher among participants (100 percent) than nonparticipants (75 percent). However, these responses may simply reflect the tendency of survey respondents to cite a program’s advertised benefits as the most important benefit of participation. Perhaps more informative are responses about the second and third most important benefits of participation. At least four-fifths of all respondents and of subpopulations of participants and nonparticipants chose “improved relations with local communities” as the second most important reason for participation. Finally, at least half of all respondents and of subpopulations of participants and nonparticipants chose “improved relations with government regulators” as the third most important benefit.

Table 5. Percentage of respondents who identified various benefits of PSA participation as 1st, 2nd, and 3rd most important

Benefit	1st most important			2nd most important			3rd most important		
	All	Participants	Nonparticipants	All	Participants	Nonparticipants	All	Participants	Nonparticipants
Forest protection and provision of environmental services	80	100	75	0	0	0	14	0	20
Improved relations with local communities	7	0	8	80	67	83	0	0	0
Improved political prospects at national level	7	0	8	13	33	8	14	25	10
Improved relations with other businesses	0	0	0	0	0	0	7	0	10
Improved relations with government regulators	0	0	0	7	0	8	57	50	60
Improved relations with ICE	0	0	0	0	0	0	7	25	0
Other	7	0	8	0	0	0	0	0	0
Total[*]	100	100	100	100	100	100	100	100	100
Number of observations	15	3	12	15	3	12	14	4[**]	10

[*] Some columns do not sum to 100 due to rounding.
[**] One respondent ranked two benefits as the third most important.

Source: Authors' survey.

The hypothesis that a primary motive for hydroelectric plant managers' participation in the PSA program was to improve relations with communities and regulators is supported by anecdotal information the managers provided in response to open-ended questions. As noted above, hydroelectric plants have significant adverse environmental impacts, a situation that has created tension with local communities. The manager of one participating plant commented that contributing to the PSA program—which amounts to a transfer of funds from the plant to local land managers—helps "improve the image of the common people about private energy plants in our area."[21] Plant managers also reported funding improvements in local roads and schools to generate goodwill. Regarding concerns about the national political and regulatory climate for private hydroelectricity, the manager of another participating plant said, "For the image of the company, the fact that we are in the PSA program will facilitate opportunities in the future." Furthermore, several plant managers were skeptical that the PSA program had a significant impact on land use and land cover change and, in some cases, opted instead for private forest conservation investments, such as paying legal expenses for those fighting land claims in national parks, funding the demarcation of park boundaries, and paying for park guards. For example, one respondent said his plant has not participated because "We don't like to give money away that will be wasted." Another said, "I don't trust MINAE, that's why I'm paying park guards directly." All of this anecdotal evidence is consistent with one of the principal conclusions of the one previous study of the user-financed component of the PSA program: political considerations, not environmental ones, are the main driver of private contributions to the program (Miranda et al. 2006).

That said, the responses to open-ended questions suggest that managers of at least some plants—including both participants and nonparticipants—believed that participation in the PSA program generates tangible environmental benefits in the form of hydrological services. However, these beliefs appear to have been based on received wisdom about the relationship between tree cover and hydrological services (as well as the effectiveness of the program). None of the plants reported carrying out an analysis of the relationship between forest cover and stream flows in their watershed.

[21] All translations by the authors.

5.3. Participants versus Nonparticipants

Multivariate regression analysis would be the ideal method of identifying characteristics of hydroelectric plants that are correlated with participation. However, with a maximum of 18 observations, more than 15 explanatory variables, and some missing observations, we simply do not have enough data for econometric analysis. Therefore, we use the second-best approach: we compare average characteristics of participants and nonparticipants. Differences between these averages indicate direct or indirect correlation between a characteristic and participation, though it is not possible to determine whether there is a causal relationship. As discussed below, a drawback of this method is that we are not able to control for correlations between the plant characteristics.[22]

We examine a wide variety of characteristics listed in Table 6, including the plant's (i) technical, financial, and contractual features (power output, annual revenue, and ownership); (ii) relationship with FONAFIFO (simple knowledge of the institution and prior contacts); and (iii) watershed (forest cover, and legal protection).

[22] For example, say that we find a positive correlation between plant size and participation and a second positive correlation between public ownership of the plant and participation. Further, say we know that these two explanatory variables are correlated; that is, large firms tend to be publicly owned. We are not able to determine whether there is a causal relationship between public ownership and participation, or just a correlation between public ownership and firm size.

Table 6. Average characteristics and perceptions of private hydroelectric firms and plants by subpopulation (n)

Characteristic/perception	Units	All	Participants	Nonparticipants	Difference in means t-test p-value[a]
Firm, plant[b]					
Power output [plant]	MW/year	6.9 (18)	16.2 (4)	4.2 (14)	0.069
Annual revenue [firm]	Year 2000 US$	2,957.0 (16)	6,057.4 (4)	1,923.6 (12)	0.074
Owned by foreign holding [firm]	yes/no	13% (16)	50% (4)	0% (12)	0.091
FONAFIFO					
Contacted by FONAFIFO re: PSA participation? [firm]	yes/no	57% (14)	100% (3)	45% (11)	0.003
Watershed					
Portion forested [plant]	%	58% (17)	76% (3)	54% (14)	0.136
Portion legally protected [plant]	%	40% (17)	33% (3)	41% (14)	0.391
PSA program performance					
How well is PSA program administered? [firm]	1=bad → 5 = good	3.64 (12)	3.67 (3)	3.63 (8)	0.479
Likely to reenroll in PSA program? [firm]	1=no → 5 = yes	n/a	4.33 (3)	n/a	n/a

[a] Test for difference in means between the participant and nonparticipant plants using one-tailed t-tests with heteroscedastic variances.
[b] Firms with multiple plants are treated as a single unit. Analysis excludes the two BOT plants and La Esperanza.

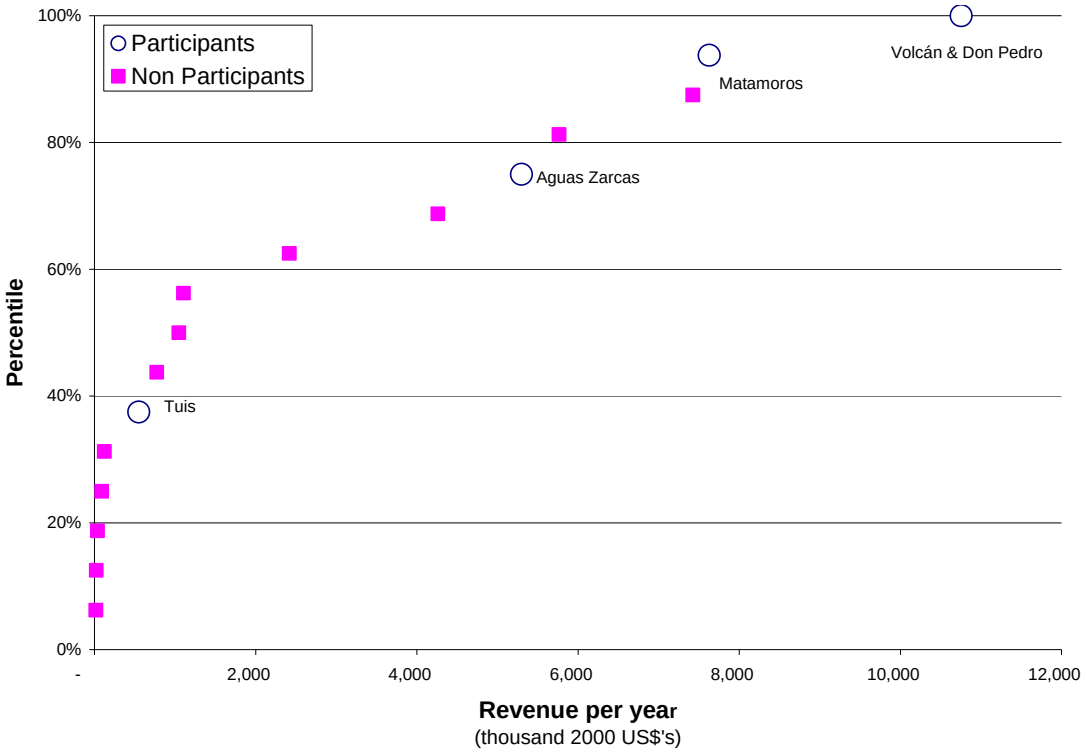
Sources: Authors' survey; ARESEP 2008.

5.3.1. Size, Revenue, Ownership, and Relationship with FONAFIFO

Our data show that average participant plants tend to be larger than average nonparticipants and to have characteristics associated with large plants, including relatively high revenues, corporate ownership, and direct contact with FONAFIFO (Table 6). Differences in all of these average characteristics are statistically significant. The generating capacity of the average participants is 16.2 MW, while that of the average nonparticipant is 4.2 MW, almost a fourfold difference. Annual revenue for average participants is $6.1 million per year, while that for average nonparticipants is $1.9 million, a threefold difference. Three of the five plants with highest annual revenue are

participants (Figure 1). It is also noteworthy that two of the four participating plants are owned by international corporations (and another is owned by a Costa Rican family that owns or operates five hydroelectric plants in Costa Rica and has developed plants internationally). By contrast, none of the nonparticipants are owned by international companies. Finally, 100 percent of participants surveyed reported having been asked by FONAFIFO to join the PSA program while only 45 percent of nonparticipants said they had been contacted. The plants not contacted tend to be among the smallest plants in the sector. Of the 17 plants for which we have data, 10 of the 11 plants larger than 1 MW were contacted by FONAFIFO, while of the 5 of the 6 smaller plants were not.[23]

Figure 1. Cumulative distribution of revenue per year for private hydroelectricplants, 1997–2007, in 2000 US$ per year[a]



[a]The first year of operation of a plant is excluded so that only full years are counted. Multiple plants owned by a single owner are treated as a single unit.
Sources: Authors' survey; ARESEP 2008.

[23] Several plants with little knowledge of the program indicated that they might be willing to participate in the program. It would seem, therefore, that there may be potential for the program to generate greater participation through more aggressive marketing. However, since the remaining plants are quite small, the cost to FONAFIFO of initiating those contacts may be great relative to the benefits that might be obtained.

Unfortunately, it is not possible to determine whether plant size, revenues, ownership, or contact with FONAFIFO are actually driving participation because these characteristics are highly correlated with each other: large plants generate more revenue, are more likely to be owned by corporations, and are more likely to have been contacted by FONAFIFO.

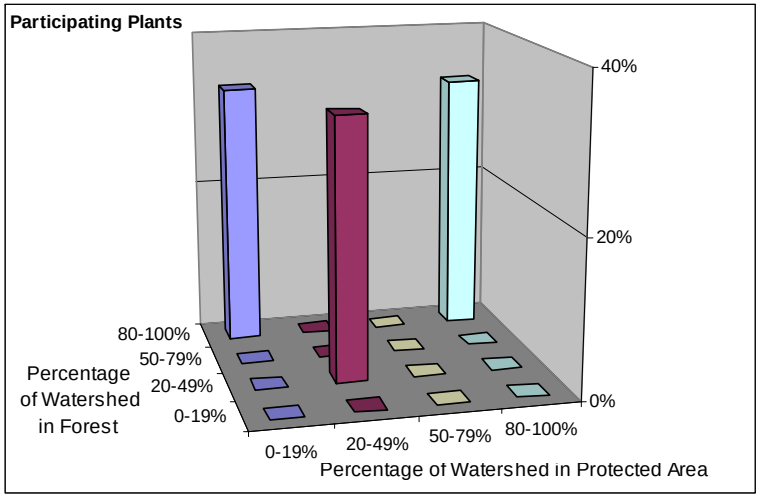
That said, each characteristic could, in theory, have an independent effect on participation. Plants contacted by FONAFIFO may be more likely to participate because such contacts reduce transaction and informational costs. High-revenue plants may be more likely to participate because they are able to afford pecuniary costs of participation, including transaction costs and payments to FONAFIFO, and because they stand to gain the most if participating improves the political climate for private investment in electricity.[24] Revenues aside, large plants may be more likely to participate because they tend to have dedicated environmental staff and, therefore, pay lower transaction costs; they also have more serious environmental impacts and, therefore, are under greater pressure from regulators, local communities, and national environmental activists. Finally, large plants and those owned by corporations may derive greater benefits from participation if they are particularly concerned about their national and international reputations.

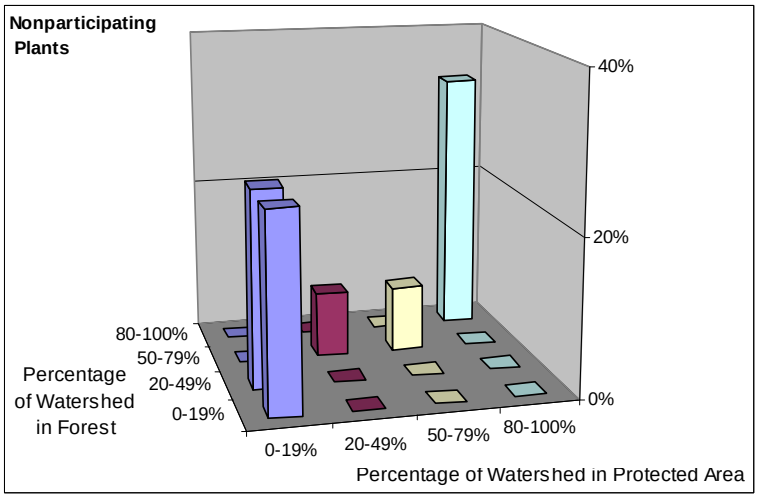
5.3.2. Watershed

The average participant's watershed is more heavily forested than the average nonparticipant's (76 percent versus 54 percent) and has a lower percentage of forest inside a formal protected area (33 percent versus 41 percent). However, these differences are not statistically significant and, in any case, do not tell the whole story. Of the three participating plants for which we have data on forest cover and protection, all are located in watersheds with substantial forest cover, and two are in watersheds that are lightly protected (Figure 2). The watershed of a third participant is mostly inside a national park, but the plant has worked with FONAFIFO to ensure that the hectares that receive payments are outside the park.

[24] In addition, to the extent they underwrite FONAFIFO payments to more hectares, they have the most to gain from participation if the relationship between payments and the provision of ecological services increases at an increasing rate—for example, if more payments ensure that forest cover exceeds an ecological threshold below which hydraulic services collapse.

Figure 2. Watershed protection and forest cover percentages for participating and nonparticipating plants





Source: Authors' survey.

What might explain the tendency of participating plants to be located in heavily forested, lightly protected watersheds? For the sake of argument, in answering this question we leave aside the evidence cited above, that plants' participation decisions are driven by local and national politics instead of concerns about hydrological services. It is important to note at the outset that PSA participation is very unlikely to have caused low rates of deforestation. Only 1 of the 18 firms we surveyed, including both PSA participants and nonparticipants, reported more than 1 percent change in forest cover in the watershed since 1998. This finding comports with data derived from satellite images indicating that deforestation nationwide has been minimal since the passage of new forestry laws in 1996 (Sanchez-Azofeifa et al. 2007; Pfaff et al. 2008). One possible explanation for the correlation between participation and forest cover is that large plants chose to locate in heavily forested watersheds to minimize uncertainty about the provision of hydrological services, and these same large plants were more likely to participate for reasons discussed in the previous section. A second is that managers of plants in heavily forested watersheds believed PSA participation had the potential to stem future clearing while those in watersheds that already were already heavily deforested did not.

As for the nonparticipants, the distribution of forest cover and protection is bimodal (Figure 2). Among the 12 nonparticipants for which we have data on watershed forest cover and protection, 58 percent were sited in watersheds that either were almost completely forested and completed protected by law, or were almost completely deforested with little or no protection. Again focusing on hydrological instead of political factors for the sake of argument, what might explain nonparticipants' tendency to be located in these two very different types of watersheds? For plants at these extremes, the potential hydrological benefits of PSA participation would have been minimal, since they either have little forest left to protect or do not need additional protection. Indeed, in open-ended responses, some representatives of these plants specifically stated that with a watershed either completely deforested or completely protected, there was very little that FONAFIFO could do.

6. In the View of Environmental Service Users, How Has the Program Performed?

The survey included two questions about the performance of the PSA program (Table 6). We asked respondents to use a Lickert scale to indicate how well the PSA program is administered (with 1 signifying "very poorly" and 5 signifying the opposite).

The average respondent ranked program administration between "ok" and "good" (3.64). Average rankings of participants and nonparticipants (3.67 versus 3.63) were not very different. We also asked participants to use a Lickert scale to indicate how likely they were to participate in the PSA program once their current five-year commitment expired (with 1 signifying "definitely no" and 5 signifying the opposite). The three participants who responded all answered "probably yes" or "definitely yes." In sum, both participants and nonparticipants believe that the administration of the PSA program is at least adequate, while participants believe that the benefits of contributing to the user-financed component of the program exceed the costs.

Yet these responses do not comport with additional survey data on plants' private investments in forest conservation. Seventy-three percent of the plants surveyed reported having made such investments. Managers of some plants participating in the PSA program indicated that they viewed these activities as complements to the program, as in the case of a plant that provides environmental tours highlighting its participation in the PSA program. However, managers of some nonparticipating plants made clear they viewed these private conservation investments as substitutes for participation in the PSA program. In some cases, their investments had the same broad objective as the PSA program—protecting forest on private land. An example was a plant that helped finance paving an access road to a nearby national park in hopes that it would boost ecotourism and dampen incentives to clear tree cover. In other cases, the private investments by nonparticipating plants aimed at ensuring benefits not provided by the PSA program. Examples include plants that invested in stemming the dumping of trash in rivers in urban areas, and in improving management of nearby national parks. The implication is that notwithstanding their positive ratings of the PSA program's administration, none of the plant managers believe the program is the most cost-effective means of ensuring the environmental health of their watersheds.

7. Conclusion

We have used an original survey of Costa Rica's private hydroelectric plants along with government statistics to analyze the user-financed component of the country's payments for ecosystem services program. We focused on three issues: (i) the number and type of environmental service users that participate; (ii) the factors driving participation in the private hydroelectricity sector; and (iii) and the perceptions of plant managers in this sector regarding the performance of the program. As for the first issue, we found that thus far, user financing represents a very small fraction of total funding for

the PSA program: excluding a single large contribution by a U.S. nongovernmental organization, environmental service users with no connection to the Costa Rican government contribute less than 1 percent of all FONAFIFO payments. Most of this financing has been contributed by facilities with a clear interest in forest hydrological services, especially from hydroelectric plants.

Regarding the drivers of participation in the private hydroelectric sector, we found that although the lion's share of plant managers interviewed—including both participants and nonparticipants—stated that the main benefit of participation was forest protection and the provision of environmental services, they also emphasized improved relations with local communities and with government regulators, both factors that figure prominently in interviewees' open-ended explanations for participating. We found that the following types of plants were more likely to participate: large plants and those with characteristics associated with large plants, including relatively high revenues, corporate ownership, and direct contact with FONAFIFO; and plants in heavily forested but lightly protected watersheds.

The data do not permit us to identify with certainty plants' motives for participating. However, we draw two broad conclusions. First, the prominence among participants of large plants that had been contacted by FONAFIFO suggests that transactions costs may be an important barrier to participation. Second, the weight of evidence suggests that improved relations with communities and regulators are as important a motive as forest protection and the provision of environmental services. In both closed-ended questions, and (especially) in open-ended questions, interviewees highlighted the importance of improved relations with communities and regulators.

Finally, as for the perceived performance of the PSA program, the average environmental service users we interviewed reported a more or less favorable impression. However, the fact that some plants are making their own private investments in forest conservation in their watersheds, instead of paying FONAFIFO to do this, suggests that plants do not view the PSA program as the only or most cost-effective means of achieving their environmental goals.

To sum up, we find that contributions to the PSA by environmental service users have thus far been minor compared with other sources of funding and—to the extent we can generalize from a case study of the leading user group—may have been motivated as much by the usual political and reputational drivers of participation in voluntary programs as by expectations that participating would ensure the continued provision of

environmental services. What are the policy implications of these findings for national PES program generally and for Costa Rica's PSA program more specifically?

As for national PES programs, we hypothesized that increased reliance on user financing might improve the efficiency of such a program. Our findings do not support this hypothesis. If environmental service users participate in hybrid PES programs for reasons other than ensuring the provision of environmental services, then they are unlikely to help government administrators identify providers of important environmental services, value these services, or monitor compliance with PES contracts. In fact, they could contribute to inefficiency. For example, if a large private hydroelectric plant in a heavily protected watershed that does not face a significant risk of deforestation contributes to a national PES program mainly to win political points, then the PES program would squander scarce resources negotiating payment contracts in a watershed where they are not urgently needed.

We also hypothesized that private financing can improve the financial sustainability of a national PES program. In this case, our conclusions are mixed. Despite the widespread perception that the PSA program offers hydrological benefits, we find little evidence that participation in the program has actually generated such benefits or that nonparticipation has entailed hydrological costs. The failure of the PSA program to significantly diminish deforestation has been shown by others (Pfaff et al. 2008; Robalino et al. 2008; Arriagada 2008; Sills et al. 2006) and is confirmed here—neither participants or nonparticipants reported significant deforestation in their watersheds. This does not bode well for the sustainability of voluntary contributions, since perceptions about hydrological benefits that are not eventually substantiated by plants' experiences are unlikely to persist. Furthermore, if finite political and reputational objectives instead of demand for environmental services drive private contributions to a national PES program, then there may be a limit on the amount that private parties are willing to contribute. For example, in Costa Rica, if contributions by private hydroelectric plants have been motivated by a need to soften political opposition, they may no longer be needed now that this opposition has diminished and the de facto ban on new investment has been lifted.

But on the other hand, if political and reputational benefits drive contributions, then program administrators can encourage contributions by enhancing these benefits. This can be accomplished by raising the public profile of the user-financed component of the PES programs, following the lead of well-known voluntary environmental programs like ISO 14001 and the U.S. EPA "partnership" programs. In addition, if participation is

driven by variations in transaction costs across ecosystem service providers, then program administrators can expand participation by seeking to lower these costs by, for example, improving marketing.

As for Costa Rica, now that hydroelectric plants and other water users are essentially required to pay part of their water tariff to FONAFIFO, and now that the deforestation rate has declined dramatically nationwide, the era of purely voluntary contributions from users of hydrological services may be nearing an end. However, there is still room for FONAFIFO to improve targeting of payments for environmental services and to provide environmental services that benefit a wider range of users. FONAFIFO could do this by reaching out to the many hydroelectric plants that have not yet participated and identifying how environmental services in their watersheds could be improved. This may involve activities other than paying private landowners not to clear forests. Although Costa Rica's deforestation rate has been substantially reduced, there remain activities that can increase the supply of environmental services, such as improving monitoring of parks or improving environmental education. Some hydroelectric plants already voluntarily fund such activities. The government can use these investments to indicate how the PSA program might be modified to provide the environmental services that Costa Ricans need most.

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Appendix: Private electricity providers in Costa Rica

Firm Surveyed	Owner	Plant Name	Type of Plant	Started operation	Operating in 2007	Power (Kw)	PSA Participant
no	Aeroenergía S.A.	Aeroenergía S.A.	Wind	1998	yes	6,750	no
no	Azucarera el Viejo S.A.	El Viejo	Biomass	≤1996	no	866[c]	no
yes	Coneléctricas R. L.	Coneléctricas R. L.	Hydro	1997	yes	17,299	no
yes	Desarrollos Energéticos MW S.A.	San Gabriel	Hydro	≤1996	yes	395	no
yes	Doña Julia	Doña Julia	Hydro	1999	yes	16,470	no
yes	Edificadora Beta	Caño Grande	Hydro	≤1996	yes	2,905	no
"	"	El Embalse	Hydro	1997	yes	2,000	no
"	"	HidroVenecia	Hydro	1999	yes	3,375	no
yes	El Angel	El Angel	Hydro	≤1996	yes	3,424	no
yes[a]	Enel GreenPower	Don Pedro	Hydro	≤1996	yes	14,000	yes
"	"	Volcan	Hydro	1997	yes	17,000	yes
yes	Hidroeléctrica Tuis S.A.	Tuis	Hydro	1999	yes	1,799	yes
yes	Holcim of Costa Rica	Aguas Zarcas	Hydro	≤1996	yes	14,208	yes
yes	Ingenio Quebrada Azul Ltda.	Quebrada Azul	Hydro	1998	yes	300	no
no	Ingenio Taboga S.A.	Ingenio Taboga S.A.	Biomass	2006	yes	20,000	no
yes[b]	Inversiones La Manguera S.A.	La Esperanza	Hydro	2000	yes	5,506	yes[b]
yes	La Lucha	La Lucha	Hydro	≤1996	yes	339	no
yes	La Rebeca	La Rebeca	Hydro	≤1996	yes	60	no
yes	Hidroelectrica Rio Lajas	Rio Lajas	Hydro	1997	yes	11,000	no
yes	Losko S.A	Poas	Hydro	1997	yes	2,125	no
"	"	Rio Segundo	Hydro	1998	yes	628	no
yes	O&M Eléctrica Matamoros S.A.	El General	Hydro (BOT)	2006	yes	39,000	no
"	"	Matamoros (various)	Hydro	1997	yes	3,819	no
"	"	Platanar	Hydro	≤1996	yes	14,594	yes
no	Miravalles III	Miravalles III	Geothermal (BOT)	2000	yes	29,500	no
no	Molinos de Viento Arenal S.A.	Tierras Morenas	Wind	1999	yes	9,480[c]	no
no	Not active	Los Negritos	Hydro	≤1996	no	39[c]	no
no	Not active	Montezuma	Hydro	≤1996	no	981	no
no	Not active	Pejibaye	Hydro	≤1996	no	49[c]	no
no	Not active	San Rafael	Hydro	≤1996	no	189[c]	no
no	Not active	Santa Rufina	Hydro	≤1996	no	292[c]	no
no	Plantas Eólicas	Plantas Eólicas	Wind	≤1996	yes	23,370	no
yes	Sociedad Planta Eléctrica Tapezco	Tapezco	Hydro	≤1996	yes	136	no
yes	Suerkata S.R.L.	Suerkata S.R.L.	Hydro	≤1996	yes	3,000	no
yes[b]	Union Fenosa	La Joya	Hydro (BOT)	2006	yes	51,000	no

[a] Former manager was interviewed, but not all questions covered in survey were asked. Current management could not be interviewed.
[b] Plant excluded from analysis for reasons discussed in Section 5.1.
[c] Estimate based on maximum actual production between 1997 and 2007 and assuming 100% operation.
Sources: ARESEP 2008, authors' survey data and calculations.