A Comparison of Conservation (Land Use) and Livelihood (Socioeconomic) Outcomes from Payments for Watershed Services Programs in Mexico

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ABSTRACT

Payments for watershed services programs (PWS) provide direct financial incentives to landowners with the aim of increasing hydrological benefits. Evidence of the impacts of PWS on conservation and livelihood outcomes remains limited, and even less is known about how specific program design features or contexts influence outcomes. We surveyed over 290 smallholders in three versions of Mexico's PWS program to test the impacts on conservation and livelihood outcomes. The three programs included: the national PWS program, a local "matching" version of the PWS program, and the latter PWS program combined with integrated water resources management (IWRM). We used matching statistics to control for observable household characteristics and bias-adjusted regression to estimate treatment effects. Households in PWS programs had higher environmental knowledge, received more information, and implemented more conservation actions than households not enrolled. There were small increases in assets owned by households in PWS compared to those not enrolled. Comparing the three PWS programs we found few differences in conservation or livelihood outcomes but significant differences in perceptions of equity in benefit distribution. Overall, our results suggest that PWS is leading to positive to neutral outcomes and that there are important differences in how the programs are perceived by smallholders.

KEYWORDS: forest conservation, human wellbeing, impact evaluation, payment for ecosystem services

INTRODUCTION

Payments for watershed services programs (PWS) are one of the more common types of payments for ecosystem services (PES) approaches being implemented in the tropics. These programs have become especially prevalent in Latin America where water scarcity and quality issues are a concern (Martin-Ortega et al. 2013). Evidence of the impacts of PWS on conservation and livelihood outcomes remains modest at best with little information on how specific program design features or contexts influence outcomes (Samii et al. 2014; Ferraro 2011; Pattanayak et al. 2010). In Latin America, evaluation of the impacts of PES programs on forest cover is increasing and studies suggest modest reductions in deforestation can be attributed to PES incentives (Scullion et al. 2011; Alix-Garcia et al. 2012; Arriagada et al. 2012; Costedoat et al. 2015; Borner et al. 2016). There remain fewer rigorous assessments of the impacts of PES on livelihoods but a few with recent analyses find little change in human wellbeing indicators attributable to PES programs (Samii et al. 2014; Arriagada et al. 2015).

One important factor that affects the ability of a PES program to effect conservation or livelihood outcomes is who participate in the program to begin with. While theoretical models of PES posit that financial incentives will 'crowd in' those individuals or communities that were demonstrating negative conservation behaviors but that have an opportunity cost less than or equal to that offered by the PES program, empirical work shows that what motivates participation and who participates is much more complex. For example, several authors illustrate that conservation motivations or values are already high in those that volunteer for PES, explaining in part the acceptance of low payments for forest conservation (Kosoy et al. 2007; Garbach et al. 2012; Figueroa et al. 2016). Non-cash benefits of PES programs also play a role in motivating participation; this includes technical assistance, in-kind materials, and the perception of payment as more secure form of income than some agricultural opportunities (Garbach et al. 2012; Jones et al. 2016). Increasingly, concern over fairness of who can participate in PES programs has emerged, with studies finding that older, larger, and wealthier landowners are better able to participate due to liquidity and labor constraints (Zbinden and Lee, 2005; Arriagada et al. 2015; Jones et al. 2016).

To advance our understanding of PES impacts we need to start with better causal models that identify the causal mechanisms linking conservation interventions to outcomes (Ferraro and Hanauer 2015; Meyfrodit 2015). This requires closer attention to variations in treatments and outcomes across programs and clear identification a priori of potential moderators, mechanisms and confounding factors. While PES programs are promoted as direct incentives for conservation, in practice PES programs are implemented alongside technical trainings, educational campaigns, and even regulations. Each of these influences program outcomes. Across PES programs there are also variations in the amount of cash paid, the requirements of program participants, and the biophysical and social context in which the program is implemented, each of which influences the ability of a PES program to achieve its outcomes.

In this paper we evaluated whether PWS programs in Mexico have led to adoption of conservation actions or changes in livelihood outcomes for smallholders in Chiapas, Mexico. The state of Chiapas provides 33% of the freshwater and 42% of the hydropower for the country, making it a priority for PWS programs (López-Báez et al. 2012; Vargas et al., 2009). Mexico's national PWS program (*Programa de Pago por Servicios Ambientales Hydrologicos*, PSAH) was launched in 2003 and was one of the first national PES schemes in Latin America. The Mexican government acts as the buyer of ecosystem services on behalf of society. The program is managed by Mexico's National Forestry Commission (*Comisión Nacional Forestal*, CONAFOR), and was created to secure hydrological ecosystem services (i.e. water quantity and quality) by reinforcing forest conservation in watersheds with a high risk of deforestation (Muñoz-Piña et al. 2008). The PWS program was started with funds from the World Bank in addition to funds from an increase in the water tariff on large water consumers and an amendment to the Federal Rights Law of 2003 that earmarked a total of MXN$200 million (US $18.2 million) per year from water fees collected (Alix-García et al. 2009; Muñoz-Piña et al. 2008). PWS has been widely adopted in Mexico, and the number of potential PWS providers has consistently exceeded available program funding (Muñoz-Piña et al. 2008; Wunder, Engel, and Pagiola 2008). As has been the case in many schemes implemented around the world (Wunder 2007; Wunder, Engel, and Pagiola 2008), the PWS has evolved into a "PES-like" scheme that diverges from the idealized market-orientation of PES programs (Perevochtchikova and Ochoa-Tamayo 2012; McAfee and Shapiro 2010; Muñoz-Piña et al. 2008).

In 2008 CONAFOR launched Mexico's Matching Program (*Fondos Concurrentes*), which added locally-funded/financed PES schemes in order to facilitate a transition from a national government-funded program to a local user-financed program that would be financed by the government in combination with the private sector and/or local municipalities (Saldaña-Herrera 2013). The Matching Program was an attempt to decentralize the national program by creating a more direct link between local ecosystem service users (i.e. water consumers) and providers (i.e. landowners). This new approach was intended to approximate the market-based orientation of PES programs by encouraging water consumers to establish contractual agreements with landowners for the conservation of forestland. In turn, local programs would diversify their funding sources, facilitating a long-term financial scheme and self-management (Saldaña-Herrera 2013; María Perevochtchikova and Ochoa-Tamayo 2012). Matching local PES programs in Mexico rely on the creation of *fideicomisos,* or trust funds, established to provide a seed grant for the conservation of ecosystem services with the participation of different actors from different political and administrative levels (Perevochtchikova 2014). CONAFOR provides a maximum of 50% of the amount needed to establish an agreement between buyers and sellers, and at least the other 50% of program

financing comes from matching funds from local service users (María Perevochtchikova and Ochoa-Tamayo 2012).

In this study we compare outcomes across three variants of PWS in Mexico: (1) payments from the national PWS program; (2) a locally financed, matching PWS program that includes some technical training; and (3) the same locally-financed, matching PWS program in combination with a government-implemented program on integrated water resources management (IWRM). All three of these variations are being implemented in communities living in the buffer zone of El Triunfo Biosphere Reserve (ETBR) located in the mountains of the Sierra Madre de Chiapas, Mexico. We selected eight ejidos to carry out our study. Ejidos are common property land tenure systems in Mexico. Mexico redistributed land holdings to peasants organized in communities following the1910 Revolution. Today, about half the country is under ejido management. Ejido land tenure systems include both private lands that are used for agricultural purposes and collective lands that are dedicated to forest or pasture. Forested ejido lands represent as much as 80% of the remaining forest in Mexico and about 50% of Mexico's national PES program payments go to ejidos. Within an ejido there are the ejidatarios, which are voting members of the general assembly, and non-ejidatarios that do not have voting rights. The non-ejidatarios are often descendants of original voting members but due to inheritance restrictions do not have the same privileges. PES contracts for protection of collective ejido forest around ETBR consist of a community level payment that is then split among ejidatario members. In other parts of the country, PES contracts are being made directly with ejidatarios that enroll their private lands in the PES program.

This research contributes to our theoretical understanding of whether PES programs can (1) motivate additional changes to land use practices that in turn lead to changes in environmental service provision, (2) have positive effects on livelihood outcomes, and (3) influence environmental knowledge and practice that may lead to longer-term impacts. Additionally, it provides insight on how program design features influence perceptions of program benefits and actual program outcomes. This direct comparison of PWS program types has not been previously conducted in Mexico and so there is little information on how additional technical assistance and trainings influence the outcomes realized. We are also able to compare perceptions of fairness across the three programs, an outcome that is gaining increasing emphasis even over changes in wellbeing. Results from this study can help refine the conceptual understanding of how PES treatment designs lead to different outcomes and how contextual factors at the community and household level influence program effects.

STUDY AREA AND PWS PROGRAMS

El Triunfo Biosphere Reserve (ETBR) was established in 1993 and includes 119,117 ha (INE 1999). Altitude ranges from 1000 to 2600 msnm and precipitation rates are between 2300-2600 mm/year.

The reserve's buffer zones are used and managed by local communities for food, medicine and other uses such as firewood (Jurjonas et al. 2016). In recognition of the pre-existing relationship between the community and its natural resources, the International Union for the Conservation of Nature (IUCN) designated the region as protected area with sustainable use of natural resources (IUCN Category IV). The reserve hosts some of the last existing cloud forests in Mesoamerica and is a refuge for dozens of rare and endemic species. The ETBR and surrounding areas are a strategic zone for water recharge, erosion control, and flood regulation for all of Mexico. Although the reserve has been identified as a priority area for Mexico as a biodiversity hotspot, significant deforestation has continued to occur due in part to cash crops like coffee which are now one of the primary sources of income for farmers surrounding the reserve (Jurjonas et al. 2016). Studies by INIFAP have found that the infiltration capacity of one ha of forest is 3.6 times more than a ha of maize and 4.5 times more than a ha of coffee (López-Báez et al. 2012).

These steep mountainous regions are highly susceptible to natural disasters including hurricanes, flooding, and landslides, (López-Báez et al. 2012). Most recently the region was affected in 2010 by Hurricane Alex and 2005 by Hurrican Stan. Additionally, changes in temperature and precipitation have made conditions more suitable for coffee rust (*Hemileia vastrix*), a fungus that is expected to reduce coffee production by up to 40 percent in the communities around the reserve (Castiaux et al. 2014). Changes in land use coupled with changes in climate continue to pose a serious threat to disaster management, food security, as well as forest conservation in this region (INIFAP 2014).

We selected eight ejidos in the buffer zone with help from PWS program implementers. Criteria for selection included program participation, access, and located with proximity of one another. The final list of ejidos included: Puerto Rico and Monte Virgen (Group 1); Nuevo Paraiso, Loma Bonita, and Santa Rosa (Group 2); Laguna del Cofre and Salvador Urbina (Group 3); and Queretaro (Group 0). Each of these communities consist of smallholders that are classified as high marginalization, an indicator of povery, by the Mexican government. The main economic activity of households is coffee and milpa, or maize and beans, is raised for household consumption. Off-farm employment is limited, with some tourism opportunities due to proximity to EBTR, and some service jobs in local towns. A large portion of households in our sample also receive direct cash subsidies from other Mexican government rural development programs such as Progressa and Procampo.

With the goal of reducing climate change vulnerability of communities buffering the biosphere reserve, three organizations—*Fondo de Conservación el Triunfo* (FONCET), *Instituto Nacional de Investigaciones Forestales y Agrícolas y Pecuarias* (INIFAP) and The Nature Conservancy (TNC)—created a locally-funded matching PWS program in 2010 that gradually builds technical capacity of small-scale farmers (Jurjonas et al. 2016). This locally managed PWS program is supporting seven communities for a period of ten years around the reserve. The locally financed PWS program requires

households to participate in technical trainings aimed at building adaptation capacity and also requires ejidos to invest a portion of the PWS payment into community projects. These community projects are to be discussed and agreed upon by all ejido members. These requirements were in response to an internal study conducted of the national PWS program that found little impact of the payments at the household level. Payments are made at the ejido level and are based on the amount of forested ha entered into the program. After a portion is taken out for community level projects, the remaining portion is split across ejidatarios. Thus, the amount a household receives is a function of both the size of the collective forest and the number of ejidatarios. The local PWS program adjusts the payment amount each year based on inflation.

In a slight variation to this local PWS program we also included communities that are part of the program and also part of an effort by INIFAP to introduce integrated water resources management (IWRM). Through IWRM, INIFAP is conducting additional capacity building workshops on climate change adaptation; building binding agreements with communities to restrict deliberate burning on farmland; teaching classes to improve sustainability of coffee production; organizing community based mapping of watersheds; and facilitating the creation of a community-based watershed governance organizations in communities (INIFAP 2014). The overall goals of IWRM are to provide resilient landscapes and communities in watersheds that are vulnerable to natural disasters. The current work takes place in six communities in La Suissa micro-watershed in ETBR but INIFAP hopes to replicate these efforts in other micro-watersheds around EBTR. Finally, the nationally-run PWS program also operates in the area, implemented by the regional CONAFOR office.

METHODS

Survey Implementation

A stratified, random sample was conducted in the eight communities in summer 2016 with similar proportions of households sampled in three PWS program types and a community without PWS (Table 1). Researchers solicited from each community a list of landowners, both *ejiditarios* and *non-ejiditarios* who were eligible to receive payments from the PWS programs, and for communities not in PWS, a list of all landowners. From this list, we eliminated landowners who were non-residents or traveling, and then conducted a random sample of landowners within the community. Those landowners who were not decision-makers on their land were excluded from the survey.

The survey was co-developed by organizations working in the region, including INIFAP and FONCET, and social scientists at CSU. It was considered low-risk by the Institutional Review Board (IRB), and documented verbal consent was obtained prior to survey implementation. The survey was translated into Spanish, piloted with households in the region and revised prior to implementation. A

representative from FONCET and or INIFAP contacted selected communities prior to data collection to introduce the study and ask approval from community leaders to conduct the survey. The survey was implemented over the course of three weeks. A total of 295 surveys were completed and average survey time was 60 minutes.

The survey contained eight themes: (1) Demographics such as age, sex, education level, and occupation; (2) Land tenancy, crops, and land quality; (3) Governmental sources of income; (4) Activities and opinions related to PWS; (5) Environmental training, practices, and knowledge; (6) Climate change resilience and adaptation strategies; (7) Information related to the *ejido*; and (8) Wealth.

<Table 1>

Data Analysis

We calculated summary statistics for variables of interest for the full sample and by group type. Differences in means and simple ordinary least squares multiple regressions were conducted on outcome variables to detect correlations. These differences are indicative of both potential differences in outcomes and potential differences in selection into the PWS programs. We are limited by the lack of pre-program baseline data and so must rely on expert knowledge of the study communities to determine which differences are attributable to the PWS and which may be confounding program outcomes.

We used matching statistics to control for possible selection bias between PWS and non-PWS communities as well as across PWS program types. Matching is a quasi-experimental method that uses observable characteristics to reduce bias (Imbens and Wooldridge 2009; Rubin 2006). There are a number of matching algorithms and estimators available. We used propensity score matching and covariate matching but only report results from the latter here. In propensity score matching, the researcher estimates a probability of receiving the treatment for each observation, and then matches units in the treatment group to those outside the program that have the closest propensity score (Guo and Fraser 2010). In covariate matching, treatment observations are matched to those that did not receive the program based on individual covariates using a multivariate distance metric (Abadie and Imbens 2006). Bias-adjustment and robust standard errors were used with covariate matching. We report average treatment effect for the treated. We checked covariate balance before and after matching using quantile-quantile plots and normalized differences in means; matching should substantially improve the similarity of observable variables between the two groups. We also checked overlap of propensity score values.

With the matched observations we can more confidently isolate program effects of PWS and across PWS types. For many outcomes we only have one point in time, but our comparison with no-PWS helps confirm changes due to PWS. For outcome variables where retrospective information was collected,

we used both change in the outcome as the dependent variable and also estimated change as a difference-in-difference equation using linear fixed effects panel regression. The advantage of the DID estimation method is that in addition to observable variables it also controls for time-invariant unobservables that can bias program evaluation (Imbens and Wooldridge 2009; Jones and Lewis 2015).

RESULTS & DISCUSSION

Household characteristics

Household characteristics were similar across all groups (Table 2). Average household size was 5 people and most people had lived more than 30 years in the region. Survey respondents were mostly male (81%), around age 50, farmers, and had attended but not completed primary school. Most respondents participated in at least two groups, with participation as an ejiditario the most common group choice. Most households had in-house plumbing and 86% reported chlorinating or boiling their drinking water; 40% of households had experienced a gastrointestinal illness in the last year. Housing construction material varied depending on the ejido location; most respondents had an adobe house but cement blockhouses were more common in Group 2 communities.

Average land holding was 11 hectares in 2015 and 2010. The amount of hectares varied considerably across communities, from three hectares in Group 1 communities to 22 hectares in Group 2 communities; this is related to the amount of land available in that ejido and number of ejidotarios. The amount of hectares changed for 22% of respondents between 2010 and 2015. Crop income was the main livelihood strategy in all communities, with more than 70% of households reporting that more than half of household income came from agricultural products. Average distance to a major market was about two hours. Coffee was the main crop across all communities, with about 80% of households reporting that they grew coffee in 2015. About 77% of households grew grain crops (milpa) and about 24% had pasture in 2015.

Almost all households received income from at least one government subsidy program in 2015, up from 91% in 2010. The average amount received by a household was about 12,000 pesos in 2015 (USD750 in 2015); this does not include payments from the PWS programs. Out of ten assets, households owned an average of five in 2010; that increased to an average of six in 2015. Self-reported community capital was an average of 29 out of 40, with considerable variation across the communities.

While PWS and non-PWS households were similar in many characteristics (Table 2), there were important statistically significant differences across these groups (not reported). PWS households rated their ejidos as being more organized, or having higher community or social capital. Community, or social, capital can affect a number of potential outcome variables from a PES program. It is unlikely that in the short time of PWS payments to these communities (2013 start; Table 1) that PWS is responsible for

higher community capital but it might be indicative of more outside programs; for example, Group 1 communities have had conservation and natural resource organizations working there for more than 15 years. Groups also varied in material wellbeing prior to the PWS programs. Ejidos are much larger in Group 2 and this translated to more land per household (Table 2). There were also statistically significant differences in the amount of income being received through other government programs.

<Table 2>

Uses of PWS payment and perceptions of benefits

For the 218 households enrolled in an ejido-level PWS program, we have information on total PWS payment from the implementing organizations (Table 1). The total payment varied with has enrolled, with a range of 34,000 pesos (USD2125) to 817,000 pesos (USD51,063) received by an ejido in 2015. The average household payment was reported as 3,200 pesos (USD200 in 2015). This varied considerably across groups as a result of the total received by that ejido and the number of households in the community that divided the payment (Table 1). As a result, less money was received on average in Group 1 because of the smaller number of has enrolled; on average Group 1 households reported receiving 560 pesos in 2015 (USD35). Group 2 households on average received 6,175 pesos in 2015 (USD400) and Group 3 households received an average of 2,230 pesos (USD 140). In general, the reported amount received varied considerably across households within the same ejido, calling into question the accuracy of this self-reported amount.

Most households used the cash from PWS to buy food for their household (Figure 1). This varied between 71% and 82% by program type. Agricultural inputs, such as seeds and fertilizer, and farm materials, such as machetes and other small tools, were the second most common expenditure. In the case of communal forest enrolled in the PWS program, this type of leakage is less of a concern. Health also ranked high for household investments, with as many as 27% of households in Group 2 using their PWS payments for these reasons. Fewer households reported using the cash for personal expenditures such as clothes or household goods.

Household responses to how the ejido was using the cash payment were more variable and many households reported that they did not know how the communal portion of the payment was being used. The primary use reported at the communal level was investment in community infrastructure including: community centers, guest housing for tourism, lights, roads, schools, and health clinics. Households were also asked to list any non-cash benefits they received from the PWS program. This varied across programs, with Groups 1 and 2 more likely to identify trainings (39% and 31% of households respectively) as a benefit over Group 3, and Group 1 households that received IWRM training more likely

to identify agricultural inputs (19% of households) than Groups 2 or 3. Group 1 (11%) and Group 3 (9%) mentioned conservation benefits as a non-material benefit of PWS, but overall this response was low.

Despite the low identification of conservation benefits when unsolicited, most households enrolled in PWS perceived the program as having a positive benefit on the environment (Figure 2). On a scale of one to five with five being "totally agree" with the statement, respondents on average reported a four or higher (agree) to statements about PWS reducing deforestation, reducing soil erosion, and improving water quality. Perceptions of PWS effects on floods were slightly lower at 3.7, and there would be less likelihood that forest conservation could mitigate large natural disaster events similar to those the region has experienced with recent hurricanes.

A series of Likert Scale questions were used to measure perceptions of household and community benefits and fairness in distribution of benefits (Figure 3). Scores were generally lower for these statements with more variation across groups. Low across all groups included statements about "everyone completes their obligations for the PWS program"; "other household incomes were improved by the program"; and that "their personal household income was improved". Across program types, there were differences in perceptions of fairness with Group 3 households reporting the lowest scores to statements about "fair distribution of household benefits" and "able to participate in decision making about PWS".

To explore whether these perceptions were statistically different we summed across all ten indicators and matched households on their education level and participation in other groups. After matching we found a statistically significant difference in Groups 1 and 3, with Group 1 perceiving more social and household benefits of PWS than Group 3 by about 4-points (maximum 50 point scale). We then considered two Likert Scale statements that most directly pertain to fairness within PWS. We found statistically significant differences across the three program types, with Group 1 reporting the highest perception of fair distribution of PWS benefits – about 1-point higher than Group 2 and 2-points higher than Group 3. We found that Group 2 had a higher perception that they are included in decision-making, with about 1-point higher than Group 3 and about 0.3-points higher than Group 1. Group 1 was also higher than Group 3 on this statement, with a statistical difference of about 1-point.

Overall, across the three PWS program types, household and communal uses of the payments seem to be similar despite the difference in the amount received, with a slight difference in perceptions of non-cash benefits from the PWS program that correspond to the amount of technical assistance provided. The difference in perceptions of fairness across PWS programs raises questions about program design, but additional study is needed to understand how these perceptions are influenced by existing social or community capital, which also varied before the PWS programs started.

<Figure 1>

<Figure 2>

<Figure 3>

<Table 3>

Conservation outcomes

Environmental knowledge was measured by four questions about the relationship between forests and water quality, water quantity, flooding, and rainfall, and one question about burning of fields and water quality. These five questions were recorded as a yes or no and summed to measure total environmental knowledge. Matching on household education level and participation in other groups resulted in statistically significant differences across PWS groups and households not in PWS programs (Table 4). On average, being in a PWS program raised environmental knowledge 0.25 points (maximum of five points).

Environmental information was a measure of having received technical information on topics from an outside organization or group. We asked about five types of information: reforestation, soil conservation practices, living fences, living filtration dams, and burning. The total amount of information received by a household varied across PWS and non-PWS households (Table 3 and Table 4) with an average increase of one item out of a maximum five with PWS. Across PWS types, when we matched with household characteristics of education level and participation in other groups we found that both Groups 1 and 2 households reported receiving more information than Group 3 households (Table 4) but that Groups 1 and 2 households received similar amounts of information. This is inline with the implementation of the local PWS programs (Groups 1 and 2) versus the national PWS program (Group 3).

Conservation actions are the most directly linked indicator to conservation of soil, water, and forest resources on individual parcels of land in the study area. Most households reported that they did not burn their agricultural fields and more than 50% of all households in our study reported having reforested parts of their land, built living fences or implemented soil conservation practices (Figure 4). The least common practice was construction of living filtration dams, with an average of 35% of all households having done this activity. Using matching we found a 0.8-point difference between the number of conservation actions implemented by a household enrolled in PWS and a household not enrolled (Table 4). Differences across each PWS program and control households varied slightly with a range of 0.7-0.9-point difference between an individual program type and no-PWS (Table 4). Across our three PWS groups, however, we found no statistical difference in the number of conservation actions implemented.

Overall, when we look across conservation outcomes we can conclude that PWS does make a difference at the household level. While environmental knowledge and information are intermediate

outcomes, and may have no measurable effect on environmental outcomes, conservation actions and behaviors are likely to be related to increases in environmental services. Across PWS program types, there was surprisingly little difference in these measures whether a household was in the national PWS program or the local PWS program, and whether they were exposed to IWRM or not. This may be due to the large number of other agricultural and conservation programs that have operated and currently operate in the region. There is a slight difference in the magnitude of the impact of different PWS program types as compared to households without PWS. For example, the treatment effect for Group 2 is 0.8 points higher than Group 3 in total information received and 0.2 points higher than Group 3 in conservation actions adopted.

<Table 4>
<Figure 4>

Livelihood benefits

We assessed changes in several objective measures of wellbeing pertaining to material wellbeing. These included an asset count, amount of land owned, amount of land rented, and number of cattle. These material items are considered important indicators of wealth in many rural communities, and some of them, such as cattle, are potentially a negative leakage of PWS payments to expansion of agricultural impacts on other lands. For each item we asked about 2015 and 2010 ownership (for assets and cattle), amount (for hectares of land) or activity (for rental of land). While recall data is subject to measurement error we tried to minimize this error by asking for presence/absence in all cases except amount of land.

For assets we collected data for a list of ten assets originally but initial summary of these items indicated that only three items had experienced variation in ownership between 2010 and 2015: cell phones, televisions and motorcycles. We summed these three assets for both years and took the difference to create the change in assets indicator. Change in assets ranged from minus one to positive three, with the majority of households in our sample experiencing no change (41%) or an increase by one asset (36%). We used the following variables in our matching equation: gender, number of persons in the household and hectares of land in 2010. Using nearest neighbor matching we found a positive impact of PWS programs on changes in assets, with a coefficient of 0.25 (maximum change of 3; Table 5). PWS Groups 2 and 3 drove this effect, with about a 0.4-point increase in assets for households in these programs compared to households not in PWS. Comparing across PWS groups, the only significant difference was between Groups 1 and 2 with Group 2 having experienced an average 0.6-point more increase in assets between 2010 and 2015.

Change in hectares across 2010 and 2015 was low with an average change of 0.2 ha and a range between -35 and 15 ha. The majority of households (78%) reported no change in hectares owned. Changes in other land measures were also low with <5% of households reporting changes in renting out their land, renting additional land parcels, hiring labor, or purchasing cattle. The largest change in livelihood activity over these five years was an increase in the number of households cultivating sun-grown coffee (12%), a switch that may increase yield but would have negative effects on ecosystem services. Because of the low reported changes we can conclude that PWS payments have had little effect on livelihoods in the region without formal testing. This could be due to the small amount of time since entering the programs (~2 years), but is more likely a result that the money received from PWS is more likely to be spent on food and other household resources (Figure 1). We used matching to test whether the amount of land had changed across groups in these five years, matching on number of persons in household and distance to markets, but found no statistically significant differences across groups (Table 5).

To get at subjective components of wellbeing we followed Arrigada et al. (2015) by asking whether respondents felt their quality of life had increased, decreased or stayed the same since 2010. Most households (57%) felt their lives had increased in quality since 2010 and 22% felt it had gotten worse. While the number of households that thought their wellbeing had improved was slightly higher in the PWS groups, this was not statistically different from the non-PWS households using matching (Table 5). This measure of wellbeing would be affected by many factors in addition to PWS participation, and we matched on age, gender and asset count in 2015. When we compared PWS groups to one another we did find a statistical significant difference between Groups 1 and 3. Group 1 households were on average 0.6 points higher, which means they were more likely to state that their lives had stayed the same or improved over time, versus gotten worse. Given the number of factors in addition to PWS that would affect this, however, we believe caution is needed in attributing the difference completely to PWS.

In general, the effect of PWS programs on wellbeing indicators were modest to null in this study area. This isn't too surprising given the number of other rural development and agriculture programs operating in these communities, liquidity and labor constraints operating in this rural area, and the small magnitude of the PWS payment received (USD35-400 annually). On the flip side we do not detect any negative impacts of receiving communal payments for forest conservation or any differences across the PWS program types in terms of wellbeing.

<Table 5>

CONCLUSION

The increasing emphasis on evidence based conservation and the use of rigorous impact evaluation methods is driving a number of new assessments of conservation interventions. Unfortunately, without randomization of program implementation or baseline data on outcomes of interest, what can be concluded in program evaluation is limited. In this study we tried to select communities that were similar on many observable characteristics but varied in PWS program implementation or design. However, some noticeable differences across communities included pre-program land ownership and assets, as well as ejido-level social capital. We further controlled for selection bias issues using matching statistics to try and detect whether PWS programs had affected (1) conservation outcomes or (2) livelihood outcomes. We found encouraging signs that PWS appears to affect conservation actions with minimal differences across PWS program design. This suggests that even the national PWS program, which does not provide as much technical training, can positively affect environmental outcomes. However, we also observed that providing more access to technical trainings did increase slightly the number of actions adopted. Future measurements of changes in environmental services, such as erosion control and water regulation, would be useful to link specific conservation actions to actual environmental outcomes. Since forest cover is conserved at the communal level in these PWS programs and we do not have land cover data we did not measure the effect of PWS on forest conservation.

A lot of discussion has ensued around whether PES programs can improve livelihood outcomes. Defined broadly these benefits would include the conservation practices that build resilient landscapes, and these types of measures were included under conservation actions adopted in this study. Defined more narrowly we might want to measure changes in material and subjective wellbeing. Households in our study used PWS payments primarily to purchase food and so it is not surprising that there were not large changes in material wellbeing indicators such as change in land size, change in renting land, change in hired labor, or change in cattle. One suggestion for future assessment would be to assess food security as a potential outcome. We did find small changes in assets owned across Groups 2 and 3 and households without PWS, and across Groups 1 and 2. The increase in assets appears correlated with the amount of cash received from the PWS program, with PWS programs and households within those programs that received more cash reporting higher changes in assets. It is possible that some of the money received from PWS, possibly in combination with other government subsidy programs, is going to purchase assets like cell phones or motorcycles. Using a broad definition of changes in quality of life we find little difference across households due to PWS, with the exception of differences in Group 1 and Group 3 households. However, unobservable factors and alternative explanations need to be more fully vetted before this statistical difference can be supported. Our lack of major differences in wellbeing outcomes is consistent with other PES evaluation studies.

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Table 1. Summary of communities

Community	**Year PWS started**	**Hectares enrolled in PWS**	**Total PWS payment to community (PWS)**	**Total population**	**Number of surveys**
Group 0: No PWS					
Querétaro	N/A	N/A	N/A	2203	73
Group 1: Local PWS and IWRM					
Puerto Rico	2010	105	77,500	322	44
Monte Virgen	2013	46	34,000	93	18
Group 2: Local PWS					
Nuevo Paraiso	2013	329	243,100	460	26
Loma Bonita	2013	1000	740,000	53	33
Santa Rosa	2013	423	313,000	21	15
Group 3: National PWS					
Salvador Urbina	2015	650	378,530	553	26
Laguna del Cofre	2013	1101	817,000	1055	56
Total					***291***

Table 2. Household Summary Statistics. Mean value with standard deviation in parentheses is reported for continuous and scale variables; the percent of respondents is reported for categorical variables.

Variable	Groups				
	All communities	*Group 1*	*Group 2*	*Group 3*	*Group 0*
Demographics					
Number of people in household	5 (2)	5 (2)	5 (2)	6 (2)	5 (2)
% Respondents male	81%	74%	70%	89%	89%
Age	52 (13)	48 (13)	52 (13)	53 (15)	56 (12)
% Respondents that started but didn't finish primary school	44%	44%	50%	40%	42%
% Respondents that identify as farmer	78%	74%	58%	90%	89%
Number of groups member of	1.8 (1.0)	2.4 (1.0)	1.7 (1.0)	1.7 (1.0)	1.6 (1.0)
Land & Crops					
Hectares in 2010	11 (14)	3 (5)	22 (21)	6 (6)	11 (11)
Minutes to a market	119 (83)	99 (62)	111 (97)	158 (90)	100 (58)
% Grow Shade Coffee in 2015	83%	85%	81%	94%	70%
% Grow Grain Crops (milpa) in 2015	77%	65%	65%	80%	96%
Financial & Social Capital					
Average government income	11,800 (11,900)	9,000 (7,000)	12,300 (17,200)	10,600 (6,870)	14,600 (12,400)

received in 2015 (without PWS; pesos)					
Asset Index 2010 (Max=10)	5 (2)	5 (2)	5 (2)	5 (2)	6 (2)
Community Capital Score (Max=40)	29 (6)	32 (4)	29 (5)	27 (7)	27 (4)
Observations	*291*	*62*	*74*	*82*	*73*

Table 3. Matching results across groups. Nearest neighbor matching with replacement using bias adjusted and robust standard errors reported. Average treatment effect for the treated reported.

Variable	**Groups compared**		
	Group 1 – Group 2	*Group 1 – Group 3*	*Group 2 – Group 3*
Perceptions of social & household PWS benefits (sum across 10 Likert Scale questions)	1.61 (1.34)	4.28*** (0.98)	1.61 (1.03)
Perceive distribution of PWS benefits as fair	0.87*** (0.29)	1.54*** (0.25)	0.42 (0.29)
Perceive that they can participate in PWS decision making	-0.29** (0.12)	0.75*** (0.21)	0.71*** (0.16)

****p<0.01 and **p<0.05*

Table 4. Matching results across groups. Nearest neighbor matching with replacement using bias adjusted and robust standard errors reported. Average treatment effect for the treated reported.

Variable	**Groups compared**						
	PWS versus Group 0	*Group 1 – Group 0*	*Group 2 – Group 0*	*Group 3 – Group 0*	*Group 1 – Group 2*	*Group 1 – Group 3*	*Group 2 – Group 3*
Environmental knowledge	0.25*** (0.07)	0.23** (0.10)	0.26*** (0.08)	0.26*** (0.08)	-0.03 (0.09)	-0.04 (0.09)	-0.03 (0.06)
Environmental information	1.05*** (0.22)	1.10*** (0.34)	1.44*** (0.23)	0.63** (0.25)	-0.15 (0.19)	0.51** (0.23)	0.76*** (0.19)
Conservation actions	0.81*** (0.17)	0.83*** (0.27)	0.89*** (0.21)	0.71*** (0.19)	0.12 (0.29)	0.02 (0.26)	-0.06 (0.22)

****p<0.01 and **p<0.05*

Table 5. Matching results across groups. Nearest neighbor matching with replacement using bias adjusted and robust standard errors reported. Average treatment effect for the treated reported.

Variable	**Groups compared**						
	PWS versus Group 0	*Group 1 – Group 0*	*Group 2 – Group 0*	*Group 3 – Group 0*	*Group 1 – Group 2*	*Group 1 – Group 3*	*Group 2 – Group 3*
Change in assets	0.25** (0.12)	-0.15 (0.16)	0.39** (0.16)	0.43** (0.16)	-0.55** (0.27)	-0.34 (0.22)	0.12 (0.24)
Change in hectares	-0.84 (0.54)	0.11 (0.67)	-0.78 (0. 95)	-1.32 (0.81)	0.21 (0.37)	-0.34 (1.23)	-1.86 (1.40)
Change in quality of life	0.02 (0.16)	-0.03 (0.25)	0.20 (0.19)	-0.09 (0.16)	0.27 (0.24)	0.56** (0.27)	0.25 (0.21)

****p<0.01 and **p<0.05*

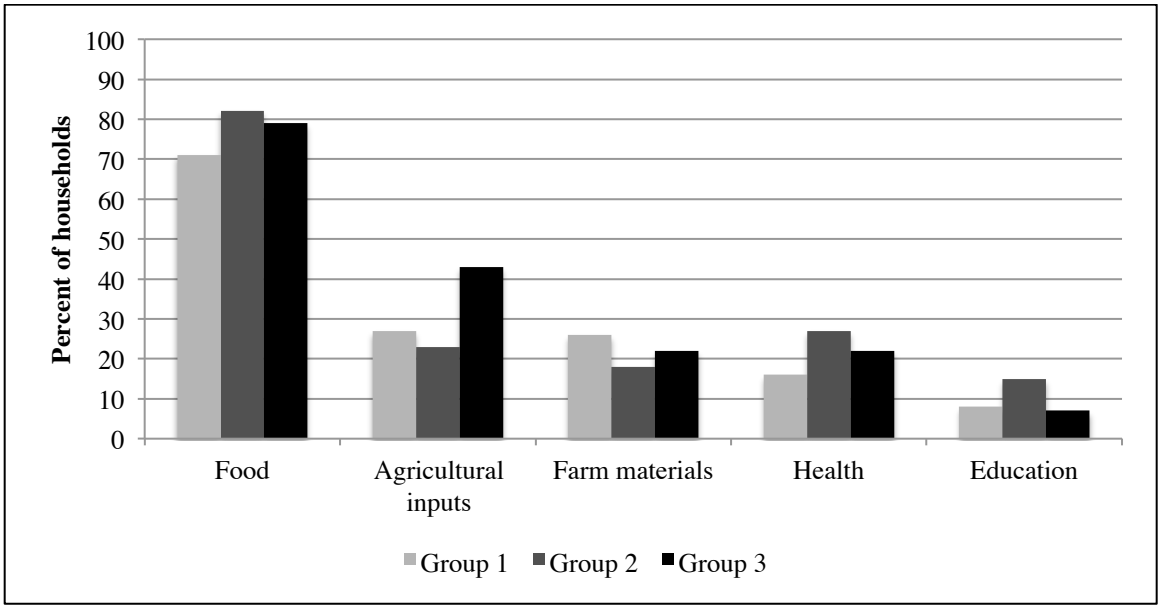

Figure 1: Household uses of PWS payment – percent of households in that group reporting that they use PWS payment for these uses

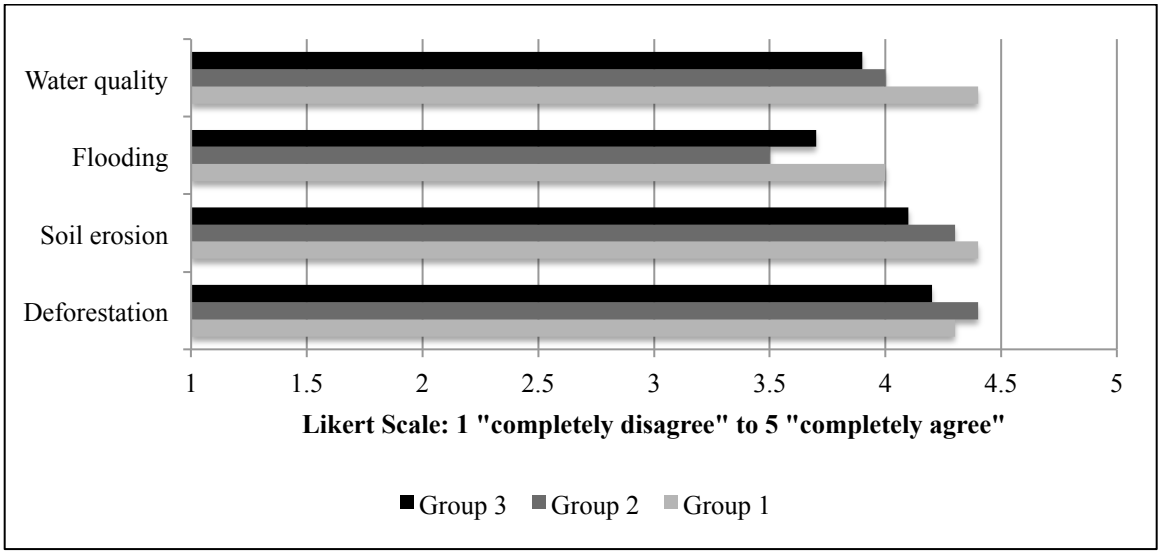

Figure 2: Household responses to Likert Scale statements about the environmental impacts of the PWS program

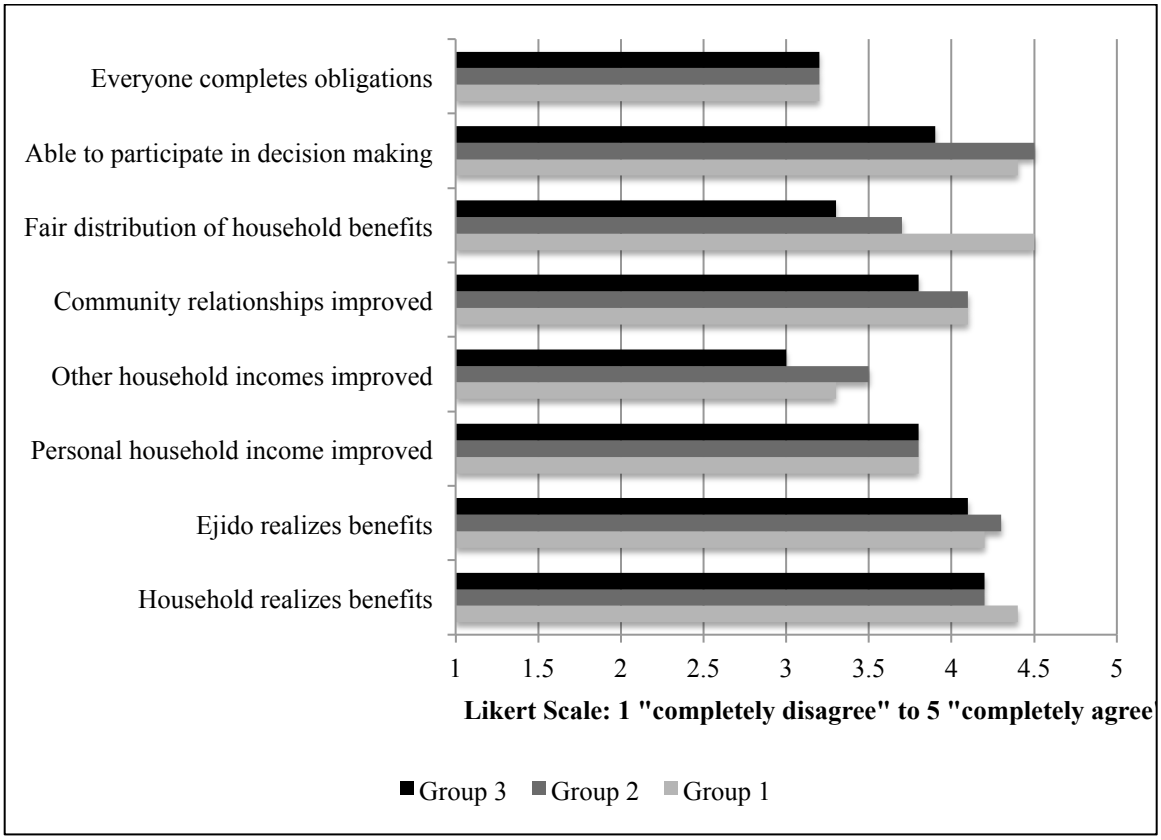

Figure 3: Household responses to Likert Scale statements about the household and community benefits associated with the PWS program

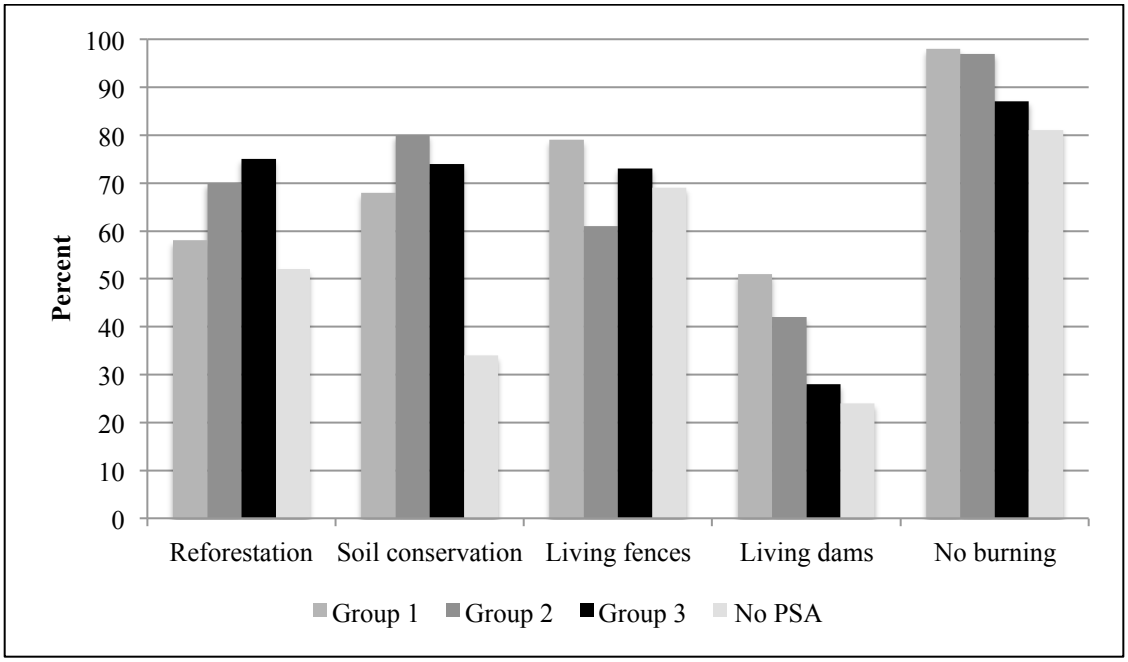

Figure 4: Household adoption of conservation actions by groups