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Land-use Behavior under the Rise and Fall of Payment for Environmental Services: Ecuador's Socio Bosque program

Tanya Hayes[a], Felipe Murtinho[a], Hendrik Wolff[b]

a. Seattle University, Seattle, WA, USA

b. Simon Fraser University, Vancouver, BC, Candada

Presenting author: hayest@seattleu.edu

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Abstract

This paper uses data from a quasi-experimental field-based study in 11 indigenous communities in Ecuador to assess the impact of the loss and subsequent uncertainty of PES payments on household land-use behavior in collective lands. We apply a difference-in difference approach to compare land-use behavior, namely grazing, in a set of PES (treatment) communities to a set of matched control communities over three time-periods: prior to when the PES program started in 2009, roughly four years into the program, and after an unexpected payment loss in 2015 and under conditions of future payment uncertainty (n=911). Results indicate that the overall treatment effect of the PES program produced a 20% reduction in grazing. Despite stated loss of motivation when payments stopped, households did not increase their grazing; rather grazing continued to decrease, even after incurring losses and in a context of future payment uncertainty.

Key Words: collective action; ecosystem services; incentives; Latin America; permanence

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1. Introduction

Can Payment for Environmental Services (PES) produce enduring environmental behaviors, even after the payments stop? This paper contributes empirical evidence from Ecuador to the debate over PES programs' potential to generate long-lasting land use behaviors**.** PES programs are increasingly used by governments and donor organizations to promote conservation in impoverished communities (Ezzine-de-Blas, Wunder, Ruiz-Pérez, & Moreno-Sanchez, 2016). While still controversial, proponents often argue that the conventional PES model is more effective and equitable than previous conservation policies as, in theory, participation is voluntary, and payment is directly linked to (and conditional on) provision of an environmental service (Engel, Pagiola, & Wunder, 2008). In low-income countries, donors and governments often see the potential for PES payments to support community development and poverty alleviation (Grieg-Gran, Porras, & Wunder, 2005; Pagiola, Arcenas, & Platais, 2005).

Recent reviews of social and environmental impacts of PES highlight the potential for PES to provide small, but positive ecological and livelihood benefits (Blundo Canto et al., 2018; Liu & Kontoleon, 2018). The continuity of PES programs, however, is often uncertain as markets and donor funding fluctuates, and contracts end (Kronenberg & Hubacek, 2013). As PES programs continue to expand across the globe, scholars and practitioners question their ability to attain sustained behavioral change, particularly when payments stop (Ezzine-de-Blas, Corbera, & Lapeyre, 2019; Hiedanpää & Bromley, 2014; Pagiola, Honey-Rosés, & Freire-González, 2016). While several studies have examined stated motivational changes and field experiments have examined behavioral change under different game scenarios (Andersson et al., 2018; Ezzine-de-Blas et al., 2019), we have limited field-based knowledge of how behaviors change as a programs progress over time, and when payments stop (Ezzine-de-Blas et al., 2019; Pagiola et al., 2016).

Here, we contribute empirical findings to the debate over the ability of PES to prompt permanent behavioral changes by drawing on data we collected over a multi-year period to examine the impact of an Ecuadorian collective PES program on land-use behaviors. Our setting is unique in that we have data on land-use behavior prior to when the PES program started in 2009, roughly four years into the program, and lastly, under conditions of an unexpected payment loss in 2015 and future payment uncertainty. Our contributions to our understanding of the impact of payment on land-use and collective resource management are three-fold. First, we use DID analysis to assess how payments, and the subsequent loss of payments impact land-use behavior in a set of treatment communities as compared to a control over the three periods in time. Second, we explore how household perception of the payment and payment loss links to motivation and actual behavior. Finally, we draw on interviews and focus group discussions to tease out why households continue to comply, even under payment uncertainty.

Our findings indicate that the Ecuadorian program has produced significant change in household land-use behavior and that households have sustained these changes even in the context of payment loss and continued payment uncertainty. Our results also show that although some households perceive an economic hardship due to payment loss and an associated loss of motivation, these households nonetheless continue to comply with land-use restrictions. Our exploratory results suggest that this may in part be due to the ability of the PES program to support communal land-use arrangements that align with communal conservation goals, as well as the ways in which PES payments have contributed to alternative livelihoods developing in the region.

2. Theoretical Foundation: Debates over economic incentives and sustained behavioral change

As initially conceived, the PES model follows neoclassical decision theory and assumes that individuals make decisions that optimize their net financial benefits in light of perceived risks (Van Den Bergh, Ferrer-i-Carbonell, & Munda, 2000; Wunder, 2005). Thus, a resource user is predicted to participate in a PES program, and provide the corresponding environmental services, only if payment is perceived sufficient to cover opportunity costs from loss of use (Wunder, 2013). Consequently, loss of payment would thus imply that the resource user would stop providing the desired environmental service (Engel et al., 2008; Fisher, 2012; Pagiola et al., 2005).

PES programs are often, however, far more complex than the simple market-based model might imply. For one, few PES programs make payments based on calculated opportunity costs, or in a true market environment (Muradian, Corbera, Pascual, Kosoy, & May, 2010; Wunder, 2013). Furthermore, contrary to neoclassical assumptions, research has found that participants join PES for a variety of economic and noneconomic benefits, many of which could feasibly continue irrespective of the continuation of payments (Bremer, Farley, & Lopez-Carr, 2014; Campbell, Sayer, & Walker, 2010; Fisher, 2012; Kosoy, Corbera, & Brown, 2008; Petheram & Campbell, 2010).

Second, PES payments are not structured as one-time interactions, but rather are linked to contracts with extended timeframes. Although the role of PES in habit making and habit breaking is arguably undertheorized (Hiedanpää & Bromley, 2014), the implicit, if not explicit goal of many programs is to use the long-term contracts in conjunction with incentives to create new resource-use habits and encourage resource users to adopt alternative livelihood practices (Hiedanpää & Bromley, 2014; Milder, Scherr, & Bracer, 2010). While some programs link incentives and sanctions for noncompliance to conservation contracts of twenty plus years, others such as silvopastoral programs explicitly link the incentives to the development of new land-use practices (Pagiola et al., 2016).

In addition, work in behavioral economics and social psychology suggests that how participants perceive the payment and how it interacts with an individual’s own values and motivation can influence the resultant behaviors (Ajzen, 1991; Bandura, 1977; Deci & Ryan, 2002; Frey & Jegen, 2001; Gneezy, Meier, & Rey-Biel, 2011). Broadly speaking, if an intervention is perceived to be controlling, leaving the individual with little choice of whether to engage in the behavior, it is predicted to erode intrinsic motivation and changes are unlikely to continue once the program ends (DeCaro & Stokes, 2008; Frey & Jegen, 2001). If, however, the program supports stakeholder participation in the design of, and participation in, the designated conservation activities, resource users may internalize the program objectives, resource use rules, and ultimately continue to engage in the conservation behaviors as they coincide with the individual’s own self-identified goals (Cetas & Yasue, 2016; DeCaro & Stokes, 2008; Ezzine-de-Blas et al., 2019).

Finally, the relationship between PES contract conditions, payment and behavioral change has become even more complex in recent years as many programs include contracts with groups or communities, and not only with individual resource owners (Hayes, Grillos, Bremer, Murtinho, & Shapiro, 2019). In the context of collective PES, group governance characteristics have been found to play a vital mediating role between program and individual participants as the decision to join, application of resource use rules and distribution of payment are often decided via collective decision processes (Hayes et al., 2019). In one of the the few framed field experiments to consider the impact of payment and payment loss in a collective resource managementsetting, Anderson et al. 2018 found that households continued to refrain from forest harvesting even after payments stopped and that in the collective setting, trust and communication were important moderating factors.

3. Context: Ecuador’s Socio Bosque payment program

In 2008, the Ecuadorian government created Programa Socio Bosque (PSB) with the dual goals of preventing the destruction and degradation of native ecosystems, and increasing income and human capital in the poorest communities of Ecuador (De Koning et al., 2011). PSB specifically targets ecosystems that are threatened, provide valuable environmental services such as regulation of hydrological systems, carbon storage, and biodiversity; and are located in the poorest regions (MAE, 2009). The government (the buyer) offers an economic incentive to poor farmers and communities who voluntarily enter into conservation contracts in which they agree to conserve native ecosystems in return for direct payments depending on the number of hectares conserved. [1] The program is not directly linked to a market and the payments are intended to act as an incentive or compensation for conservation behaviors; the payments are not based on calculated opportunity costs (De Koning et al., 2011). The program works with both individuals and communities, however, 88% of the conservation lands are under community contracts (MAE, 2012).

This study focuses specifically on collective contracts made with rural communities to conserve Ecuador's highland ecosystems, namely *páramo* lands. In 2009, PSB created a specific unit dedicated to the conservation of páramo. Páramo, a high-elevation ecosystem of grasslands and shrubs (at about 3500 m), provides critical ecosystem services, namely water provision and carbon storage in the soils (Buytaert & De Bièvre, 2012; K. Farley, Kelly, & Hofstede, 2004; Farley, Anderson, Bremer, & Harden, 2011; Madriñan, Cortes, & Richardson, 2013). In Ecuador, over 3 million people directly benefit from the páramo's water supply (Crespo et al., 2010).

As in much of the northern Andes, in Ecuador, the páramo is threatened by urbanization, subsistence land-use activities and climate change. Specifically grazing and farming in the páramo, in addition to afforestation, urbanization, and hotter and drier climate threaten to degrade and destroy the páramo and its water storage capacity (Buytaert et al., 2006; Crespo et al., 2010; Hofstede et al., 2014; Madriñan et al., 2013).

As of February 2013, PSB had signed 47 contracts with highland communities, encompassing approximately 42,000 hectares of land and 15,000 households. In signing the PSB contract, communities agreed not to burn, hunt, practice agriculture, or introduce non-native species or any activities that may impact the conservation value of the designated area. In addition, participants agreed to limit grazing in the páramo to less than semi-intensive levels, although no formal guidelines are given as to what constitutes semi-intensive levels (MAE, 2009). Communities were responsible for crafting appropriate management rules and transmitting these rules to all constituents.

Contracts are for twenty years and payments were supposed to be made twice a year to the community governing body on the condition that the communities conserve their páramo. Payments are intended to be used for community development projects in accordance with community investment plans (Krause, Collen, & Nicholas, 2013; MAE, 2012). In our study, yearly payments to the communities averaged USD 19,932 (SD 10,138). Use of the money varied by community and often included a mix of

[1] It is important to note that the Ecuadorian government does not recognize Programa Socio Bosque as a PES program, however, the conditions coincide with what is generally considered PES.

direct payments to households, investment in agricultural and dairy production, and communal projects such as schools, stadiums and roads (Hayes & Murtinho, 2018).

Our previous work used a quasi-experimental design to assess the impact of the program on household land-use behavior and communal governance (Hayes, Murtinho, & Wolff, 2015; Hayes, Murtinho, & Wolff, 2017). Our studies assessed communal resource management arrangements and household land use behaviors in a set of participating communities compared to a matched set of control communities. Our results found that between 2008 and 2013, the Ecuadorian PES program successfully strengthened communal land-use rules and reduced household use of the respective communal lands (Hayes et al., 2015; 2017). Difference-in-difference analysis showed that households in participating communities significantly reduced their use of the collective lands when compared to households in a control community (Hayes et al., 2017).

PES payments started in 2009 and were supposed to run for twenty years. At the end of 2015, after approximately seven years in operation, the Ecuadorian PES program lost financial support and abruptly stopped payments. As a result, program personnel was reduced from approximately 60 to four employees, and all field personnel were dismissed. Communities did not receive payment for three payment cycles (1 ½ years)**.** In April 2017, payments resumed, but as of 2019, the program had been unable to fully repay the communities for lost payments and future payments were continually late and uncertain.

4. Methods

4.1 Case Selection & Location

This study examines the influence of PSB in Quichua indigenous communities located in the central highlands in the provinces of Tungurahua and Chimborazo (see figure 1). We chose to study the central highlands because the majority of PSB's work with communities in the páramo (68%) has been in this region. The páramo in Tungurahua and Chimborazo is critical for providing water to the highland cities, and also provides water for hydroelectric power in three provinces (Gortaire, 2012). The páramo is also home to many poor, rural residents who use the páramo for grazing sheep and cattle, and agriculture activities. Approximately 60% of the population lives in rural areas, and roughly 90% of the rural population is unable to meet its basic needs (INEC, 2013).

Here, we compare páramo use in six participant communities and five non-participant communities. To address potential self-selection bias (Alix-Garcia & Wolff, 2014; Miteva, Pattanayak, & Ferraro, 2012), our research design takes advantage of the spatial roll-out of the PSB program. PSB began working in the Central Andes in 2009 and continued to recruit communities. In 2013, our study gathered data from communities that had been participating for the past two-five years and matched those communities to a set of communities that had indicated interest in joining PSB and were on an informal waitlist.

Treatment and control communities were selected using quasi-experimental matching to control for possible observable sources of bias. Communities were selected based on the following criteria: identify as Quichua indigenous communities; households depend principally on farm-level activities for their livelihoods; communities had been using the páramo prior to 2008 when PSB entered the region; páramo is located at relatively similar altitudes and with similar topography; and, most residents can access the páramo by walking from their houses in less than 3 hours. The communities are representative of the distribution of community sizes and páramo sizes common to the region (please see Table 1 for community characteristics).

<INSERT TABLE 1 HERE>

The residents in our study communities established their communal lands in the 1960s and 1970s as various stages of Ecuador's Agricultural Revolution broke up large haciendas and permitted indigenous and mestizo (of mixed Spanish and indigenous descent) laborers to purchase lands communally (Korovkin, 2002). While all study communities have recognized informal titles, not all of the communities have current official titles in hand.[2]

Across all communities, residents derive their livelihoods principally from agriculture and grazing. At lower elevations, households maintain individual parcels for household agriculture and animals. At higher elevations, the páramo has historically been used collectively for extensive grazing, housing materials, fuel, and medicinal uses. These collective lands, although rarely the main source of income for families, can be an important part of a household's livelihood portfolio, and are an important seasonal resource for some families (particularly in times of drought) (Albán & Argüello, 2004; Bremer, Farley, Lopez-Carr, & Romero, 2014; Hofstede et al., 2014).

By law, each community is governed by an elected "executive body" that represents the community in all external relations with governmental and non-governmental organizations, and is charged with governing the day-to-day activities in the community. The executive body works with the

[2] Legal title to communal lands is a pre-requisite for entering into PSB. At the time of our study, two of the non-PSB communities did not have legal title and were working on filing the paperwork to have their informal titles legally recognized.

community to make budgetary decisions, organize community assembly meetings and *mingas* (work parties), create and enforce community norms and rules, and mediate conflicts (Korovkin, 2002).

In our case study communities, all communities recognized at least one páramo-use rule, namely a ban on burning the páramo, however, communities differed in rules regarding grazing in the páramo. In our sample, six communities had previously devised grazing restrictions for the páramo. The communities had crafted these rules at least ten years prior to 2013, with the majority crafting rules circa 2000.

The PSB contracts are the most direct formal rules by the government to regulate páramo use. Ecuador does not have a national law to protect the páramo (Morales & Rivadeneira, 2011). With the exception of a ban on burning (explicitly applied to páramo in 2014[3]), national conservation laws largely consist of general stipulations to protect fragile ecosystems and biodiversity, many of which are weakly enforced (Echeverría & Suárez, 2013; Esty & Porter, 2001; Morales & Rivadeneira, 2011). In our case study communities, all communities had received some education on the importance of the páramo, and all had received some sort of technical assistance for agricultural development. None, however, had participated in a payment program prior to PSB.

<INSERT FIGURE 1 HERE>

4.2 Conceptual framework, hypotheses and variables

We use an adapted version of the Institutional Analysis and Development (IAD) framework to systematically incorporate a variety of theories and subsequent variables to assess how payment loss impacts land-use behavior (McGinnis & Ostrom, 2014; Ostrom, 1990, 2005, 2011). Figure 2 shows the basic components of our adapted IAD framework. We direct the reader to table 2 for a description of each variable used within our statistical analyses, and appendix A for the descriptive statistics of participant and non-participant communities

<INSERT FIGURE 2 HERE>

4.2.1 Dependent Variable

In our assessment of behavioral change, our outcome of interest is the household decision to graze animals (cows and sheep) in the collective páramo. We chose to focus specifically on grazing based on

[3] Note that our research found that the majority of communities already had rules prohibiting burning prior to the formal ban (which was established after our research was conducted). See authors 2015.

discussions with PSB extension agents, and other stakeholders, on the principal threats to the páramo, and results from a previous survey on communal land-use practices administered to leaders in participant and non-participant communities across the Ecuadorian highlands (Hayes et al., 2015).[4] Following the neoclassical model, we hypothesize that from 2015-2017 loss of payment and continued payment uncertainty will result in an increase of household use of the collective lands for grazing as compared to 2008 to 2013 when payments were initially received and grazing was shown to significantly decline in participant communities (Hayes et al., 2017).

4.2.2 Independent variables

In addition to the payment, and associated contract condition, other economic and non-economic household attributes, communal conditions and programmatic factors may also influence a household's land-use decisions and potentially mediate the impact of payment loss on grazing behavior. In our statistical analyses, our independent variables consist of biophysical features, household characteristics, attributes of the community and its governance system, and attributes of the PES program that may influence páramo use.

We minimize biophysical differences by focusing on one particular resource system (páramo). All páramo is located in the same central region of the Andes and at roughly the same elevation (3,700 to 4,200 meters). In the case study communities, the main physical variation among communities is páramo size.[5] On average, PSB communities had slightly larger páramos and greater populations; however, both participant and non-participant communities spanned a range of community sizes which is typical of the highland communities in the region.

At the household level, we include demographic and socioeconomic attributes, in addition to perceptions of the páramo in our analysis. Household attributes include the number of cows a household owns, area of pasture owned, relative wealth, proximity of household to the páramo, age, and perceived value of the páramo (economic or environmental) (Anley, Bogale, & Haile-Gabriel, 2007; Koontz, 2001; Robbins, McSweeney, Chhangani, & Rice, 2009; Sommerville, Milner-Gulland, Rahajaharison, & Jones, 2010). We expect that households with more cows and less land or wealth will be more dependent on the collectively owned páramo, and therefore, more likely to be grazing in the context of payment loss. Likewise, we expect that older households and those that live farther from the páramo will be less likely to graze the páramo as they have less access the more remote lands.

[4] The survey included almost a complete census (44 of 47) of highland communities participating in PSB.
[5] Note that we are unable to assess more sophisticated biophysical features such as slope because of lack of appropriately georeferenced data on the location of the páramo lands for non-participant communities.

The relationship between environmental beliefs and environmental action is complex and contested (DeCaro & Stokes, 2008; Dietz, Fitzgerald, & Shwom, 2005; Rode, Gómez-Baggethun, & Krause, 2015). Nonetheless, based on previous work on non-material benefits derived from PES (Bremer et al., 2018), and our previous findings on conservation attitudes and land-use behavior (Hayes et al., 2017), we predict that households that perceive ecosystem benefits (as compared to economic use benefits) from the conservation lands will be less likely to graze their animals in the collective lands, even under conditions of payment loss and uncertainty.

With respect to communal governance attributes, we include a set of variables that researchers have consistently found to influence household resource use: the capacity to self-organize, history of land-use rules, monitoring activities, and the perceived likelihood that those performing illicit activities would be caught (Andersson, Benavides, & León, 2014; Berkes, Folke, & Colding, 1998; Gibson, Williams, & Ostrom, 2005; Ostrom, 1990). Drawing on previous research, we predict that households in communities with a history of conservation rules for their collective lands, stronger organizational capacity, and monitoring and enforcement mechanisms will be less likely to graze in the collective lands, even under loss of payments (Coleman & Steed, 2009; Gibson et al., 2005; Hayes et al., 2017; Ostrom & Nagendra, 2006; Persha, Agrawal, & Chhatre, 2011).[6]

Finally, the principal treatment in the analysis is the PSB contract and the respective payment, and loss of payment. We expect that size of payment as well as length of program participation may influence the effect of the treatment on household behavior under payment loss and uncertainty. We predict that households living in communities with larger payments will be more likely to graze in the collective lands under loss of payment as the economic loss will be more visible to these households. Likewise, we expect that communities that have been with the program for longer periods will be more likely to keep their animals off the collective lands, even when payments stop, as they have had longer time to change their land-use habits and develop alternatives (Hiedanpää & Bromley, 2014).

We also consider how programmatic characteristics, and particularly perceptions of the program, may influence resource use. While we are unable to include these variables in our DID analysis perceptions of the program and the payment do not apply to the control communities, we are able to explore how these factors may be influencing behavior using descriptive statistics for data gathered in the participant communities. To further understand our DID results, we consider how household perceptions of the need for land-use restrictions, their autonomy within the program to decide land-uses, the overall fairness of the

[6] In our DID analysis we use perceive catch (whether respondent perceives if it is likely that someone would be caught if the person does not obey a communal rule regarding the use of páramo) as proxy for monitoring and enforcement and previous land-use rules, as these variables are highly correlated.

program, and the impact of payment loss on their well-being, the trustworthiness of the program personnel further support sustained behavioral change (Ezzine-de-Blas et al., 2019).

<INSERT TABLE 2 HERE>

4.3 Data gathering

Our analysis uses data gathered via a household questionnaire to assess land-use behavior over three time periods: 2008; 2013; and 2018. This data is further supplemented and triangulated with focus group transcripts, transect walks and rapid páramo assessments, and land use change through the analysis of land cover images over time.

4.3.1 Household questionnaire

The data for the statistical analysis was gathered via a cross-sectional household survey administered in two points in time (2013, 2018) for a total sample of 911. Households were selected using a stratified random sampling process based on geographic proximity to communal lands. The male or female head of household was asked to respond to the questionnaire about household activities (50% of the respondents were female). In the smaller communities (n<50), we administered the questionnaire to a minimum of 50 percent of the households, in the larger communities, we interviewed a minimum of 10 percent of the households (see Table 1). In total, we interviewed 419 households in 2013 and 492 households in 2018.

The questionnaire was orally administered by trained local interviewers with expertise in highland communities. Interviewers were instructed to clearly state that they had no alliances with governmental or non-governmental organizations working in the region and that all interviewee responses would be confidential. Interviews were conducted in Spanish and included closed and open-ended questions about the activities of the household including land-use practices and livelihoods, use of the páramo, and participation in governance activities. Program participants were also asked about their knowledge and perceptions of the impact of the program. Questions regarding program participation, however, were at the end of the interview so as not to contaminate participant response.

Páramo use was assessed by a set of questions that asked households to recall whether the household grazed cattle or sheep in the collective páramo in 2008; whether the household grazed cattle or sheep in the páramo in the present day (2013); and again in 2018. Grazing behavior in the páramo is not necessarily consistent throughout the year. The survey specifically asked the respondent about their grazing behavior over the entire year, and explicitly asked where the respondent grazed livestock in the dry season, and during times of drought.

We recognize the limits of using self-reports to assess páramo use, and particularly past páramo use (Thornberry & Krohn, 2000; Tourangeau & Yan, 2007). In addition to assurances about the confidentiality of their responses, we aimed to increase the reliability of the respondents answers by asking several questions that positioned páramo use as a common livelihood strategy and gave respondents both closed and open-ended opportunities to discuss if and how they use the páramo and how their use had changed (Schaeffer & Presser, 2003; Thornberry & Krohn, 2000). To address memory failure in the recall question for 2008, interviewers were instructed to establish a timeframe of reference for each respondent (Raphael, 1987; Schaeffer & Presser, 2003). In addition, for recall questions, rather than ask about the number of animals a household grazed in the collective páramo in the past, we asked about grazing behavior in terms of gradients of use (more today or less today) as this would be easier to recall. Later, these gradients of use were triangulated with other land use responses (from close and open-ended questions) in order to create the binary variables.

4.3.2 Triangulation of household stated behavior

To further validate our questionnaire results, we triangulated the household information with focus group discussions, key informant interviews, and an observed assessment of the use and condition of the páramo.

Focus groups were conducted with elders and community leaders in 2013 and 2018. In 2018, we divided focus group discussions by gender to receive more input from women in the respective communities. During discussions, interviewers created a timeline to establish key events and identify an event that occurred approximately five years earlier (2008, and 2015 respectively). These events were then used to help survey respondents recall earlier practices. Members also drew a map of the community and páramo lands, discussed the governance issues on the communities' lands, and compared rules that existed according to the 2013 interviews to those that existed in 2018.

We further verify stated behavior with observed land-use data in 2013 and 2018. The páramo assessment was a rapid field assessment to identify current land-uses in the páramo and the state of degradation. A biologist with expertise in páramo systems walked a set of transect lines that were purposefully selected to cover the various land-uses and land-covers in each páramo and prioritize more accessible areas (Peralvo, 2013). The transect lines started at the top of a community's páramo and moved toward lower elevations and evidence of cattle, sheep and fires were documented along the lines. Georeferenced samples were taken every 500 meters, or less if the land-cover or land-use changed within the 500 meter line. The páramo assessment is limited in its ability to measure páramo use as it is based only on evidence at one point in time, nonetheless, the observation of current or recent grazing activity helps to further verify the focal group and household information on the overall extent to which community members use the páramo. The analysis is further supplemented by an analysis of aerial and satellite images from 2000; 2010 and 2018.

4.4 Econometric Model

We use the difference in differences (DID) framework to estimate the treatment effect of PSB on grazing (Imbens & Wooldridge, 2009). Here we take advantage of the gradual rollout of the PSB program and the subsequent loss of the payments and distinguish between "treated" households and "control" households. We are interested in three sets of regressions.

The first estimates the primary DID treatment effect of PSB using the data from 2008 to 2013. These regressions are analogue to Hayes et al. (2017), measuring the effect of PSB on grazing. Treated units are those that enrolled in the PSB ($PSB_i = 1$) and the control units ($PSB_i = 0$) did not enroll yet at the time of the survey in 2013. In addition, we separate between the treatment period ($T = 1$) and the control period (T=0). The treated period is at the point of time of our survey in 2013 and the control time is 2008, hence five years prior to the survey when no one was enrolled in PSB. Our basic DID specification is given by equation (1), in which households are subscripted with i in community c and time is subscripted with t:

$$grazing_{cit} = \alpha + \beta PSB_i + \gamma T_t + \delta^c Treat_{cit} + \eta C_c + \varphi H_i + \varepsilon_{cit.} \quad (1)$$

Our dependent variable is the dichotomous indicator $grazing_{cit}$, assigning whether the household i grazed their animals in the collective páramo c ($grazing_{cit} = 1$) at time t = {2008, 2013}. If household i did not have animals grazing inside of the páramo at time t, the dummy is set equal to zero. The treatment effect variable $Treat_{it}$ is equal to the multiplication of the PSB_i and T_t. Hence, our parameter of interest is δ which shows the causal effect of the percentage change in grazing due to the PSB. In additional specifications, we further unpool the treatment effect by community indicators c, hence δ^c, to test which communities have significant PSB effects. In robustness checks we further control for a set of variables C that vary at the community level c *and* a set of variables H that vary at the household level i. We direct the reader to table 2 for further description of the communal and household variables used in the model. Finally, to account for community level peer effects as well as autocorrelation, we cluster our error term ε_{cit} at the community level.

In our second set of regressions we estimate the DID treatment effect over the entire time horizon of ten years, from 2008 to 2018, which includes the start of the PSB program in 2009 and then the unexpected halt of the PSB in 2015. These regressions are analogue to the regression in equation (1), with 2018 data replacing the 2013 data.

Finally, our third set of regressions focus on the time period of 2013 to 2018. This set of regressions has the advantage that both the 2013 and 2018 data are directly measured (and do not rely on the recall data of 2008). Here, we use 2018 as the treatment year and 2013 is the control year. Hence the results are to be interpreted as the effect of the unexpected loss of payments on the land use behavior.

3.4 Study limitations

In reading the results, we caution the reader to consider several potential limitations. First, in our research design and analysis, we have tried to account for differences between participant and non-participant communities, nonetheless, unmeasured *unobservable* variables (these would be in ε_{cit}.) could still be correlated with the treatment indicator and this would bias our DID estimates. This assumption is hard to circumvent as we do not have any viable instrumental variables for program enrollment. Following the intuition laid out by Altonji, Elder, and Taber (2000), we examined the potential for omitted variable bias by testing the robustness of our DID estimates to an array of community and household specifications and consistently found similar treatment effects. In particular we turn on and off the explanatory variables population density, number of cows, area pasture, wealth index, distance to paramo, age, perception paramo, self-organization and perceive catch and find that the inclusion or exclusion of all or a subset of these variables lead to qualitatively similar regression results of the overall treatment effect. While the stability of our estimates across these different DID specifications is reassuring, we acknowledge that our research design cannot conclusively rule out the possibility that unobserved factors are influencing our estimates. It would, however, be difficult to come up with a story of an unobserved driver that is correlated with the treatment variable but uncorrelated with the set of community and household controls.

Second, we recognize that the binary condition of completely stopping grazing does not fully capture potential reductions in grazing, however, we consider it to be a more accurate measure of grazing behavior than the specific number of cows a household grazed in the páramo.

Third, our analysis of community governance institutions is limited by the relatively small number of communities that met the quasi-experimental design selection criteria for the study. Thus, while the findings suggest that in collective PES a number of communal factors may mediate program implementation and the likelihood that land-use behaviors will be sustained, the small number of communities limits our ability to isolate how specific communal elements shape behavior when payments stop.

5. Results

5.1 Impact of payment loss on household land-use behavior of conservation sites

Figure 3 shows the percent of households grazing in the PES treatment communities as compared to the control communities for 2008, 2013 and 2018. As seen in table 3, Differences in Differences results indicate that the overall treatment effect is -0.20 (Confidence Interval: [-8%, -32%]), a 20% reduction in grazing between 2018 compared to 2008 due to program participation.

<INSERT TABLE 3 HERE>
<INSERT FIGURE 3 HERE>

The results indicate the greatest decline in grazing was between 2008 and 2013 (δ = -0.12; 95% Confidence Interval: [0%, -24%]). Although the change in grazing between 2013 to 2018 is not significant, participant communities continued to reduce their grazing in the collective lands even after payment loss by 6% with very few households reporting páramo use in 2018.

The stated behavioral findings correspond with our observed data from the páramo assessment transect walks and with a preliminary analysis of aerial and satellite images from 2000, 2010 and 2018. In our interviews and transect walks we found that despite statements of frustration or loss of motivation, there was no indication that residents returned to grazing or increased any páramo use after 2015 when communities lost payments.

The results, are not, however, uniform across all communities. Figure 4 shows the percent of households grazing in PSB (treatment) communities and control communities in 2008, 2013, and 2018. It is important to note that grazing is declining across all communities. The DID results suggest that in addition to the PSB treatment, other factors are also influencing the decision to graze. Namely, as expected, across all communities, those households with more cows are more likely to use the collective lands for grazing. Alternatively, households that expressed an appreciation for the ecological value of the páramo (as compared to extractive values) are less likely to graze in 2018. Irrespective of cows or attitudes toward the páramo, however, the PSB treatment remains significant.

<INSERT FIGURE 4 HERE>

It is also important to note the variation in grazing reductions within the set of PSB treatment communities. DID results indicate that community A and community F differ from the others (please see appendix B). In community A, we see the greatest reduction in grazing as 82% of the households responded that they were using the collective páramo for grazing in 2008 prior to participation in PSB, none reported grazing in 2013, and one reported grazing in 2018. This community had one of the highest payments per household of the six participant communities with total annual payment of 37,735 USD and each household directly receiving close to 800 USD per year

In contrast, in community F, we see the least reduction as only 35% of the households were grazing in 2008 prior to joining PSB. Furthermore, while the households reduced use between 2008 and 2013, there was little decline after 2013 with 6% reporting that they grazed in the páramo in 2018.

4.2 Perceived Impacts of Payment Loss and Continued Compliance

4.2.1 Perceived Impacts

In response to questions about how perceptions of payment, and subsequent payment loss impact resource use behavior, Table 4 focuses specifically on the PSB communities and illustrates how the decline in grazing compares to perceived economic dependency on the PSB payment and stated attitudinal changes, namely motivation and perception of the PSB program. As indicated in table 4, the size of payment and the perceived impact of the loss of payment on households and on the ability to realize communal projects varies across communities. It is important to note that communities often split the payment across a mix of communal projects and household investments in agricultural inputs or loans, and in some cases, direct cash to households.

<INSERT TABLE 4 HERE>

Table 4 illustrates three important trends. First, not surprisingly, in communities with the largest payments per households, households were more likely to perceive that loss of payment had impacted their ability to pay for basic household necessities ($t=-10.01$, $p=0.000$, $n=138$). To put the payment size into perspective, the average payment per household in community A was $800. At the poverty line of $5.50 per day, this is approximately 40% of an individual's yearly income.[7] While not all communities divided the cash across households, our research found that those communities with larger per capita payments were more likely to divide part, if not all, of the payment across their constituents.

[7] $5.50 is the international poverty line for middle-upper income countries such as Ecuador http://povertydata.worldbank.org/poverty/home/

Second, households that perceived the greatest impact from payment loss were also more likely to state a loss of motivation to conserve their communal lands (Chi=4.671, p=0.031, n=137) and a loss of trust in the program and its ability to fulfill its promises (Chi=5.248, p=0.022, n=137). Third, however, contrary to our expectations, there is no association between motivation loss and grazing. Despite stated motivational loss from loss of payments, there is no evidence that households returned to grazing. Households in communities A and B are particularly illustrative of this disjuncture between loss of payment, motivational loss and actual land-use behavior. Households in these two communities received some of the highest payments and felt some of the greatest impacts for the loss of payments, yet despite complaints about the program and a loss of motivation, households continue to comply with the land-use restrictions.[8]

4.2.2 Why do they still comply?

Recognizing the limits of our small sample, here we draw on our interviews and focus group data to explore reasons why, despite evident losses, households continue to refrain from grazing in the collective lands. Our exploratory findings suggest how program alignment with communal values, communal leadership and respect for program personnel, and changing land-use trends in the region may all be contributing to sustained conservation behaviors.

First, our results indicate that the majority of households perceive program alignment with communal conservation goals and their responsibility to manage their lands. Previously, we found that in addition to the economic incentives, communities often decided to participate in the PSB program for the environmental benefits derived from páramo conservation (Hayes & Murtinho, 2018). Community C is a case in point. In focus group discussions, leaders and elders noted that in the early 1990s they began to recognize the hydrological value of the páramo and the need to protect their lands. They struggled, however, to convince community members to stop grazing in the collective lands. The decision to join PSB, was in part, a means to further legitimate incipient communal conservation rules.

Community C was not unique in its appreciation for how PSB further supported the development of communal land-use regulations. In our household survey in 2013, 72% of households stated that program participation had helped to clarify their land-use rules. Households, however, did not perceive that PSB was setting the rules. Across all participating communities, more than 90% of the households said it was the community that made the land-use rules regarding their collective lands (Hayes et al.,

[8] We note that one household reported grazing in community A in 2018, whereas none reported grazing in 2013. This is not, however, a significant change in grazing across the community.

2015). While PSB may have facilitated this rule-making process, households perceived ownership over the governance arrangement. In 2018, in response to questions asking why a household continued to conserve their collective lands, many responded that it was their responsibility to care for their lands and they would continue to do so irrespective of payment; 75% of households in participant communities supported having land-use restrictions in the páramo.

Second, interview and focus group discussions highlight how communal leadership and perceptions of PSB further contributed to this supportive relationship. Residents often reported that communal leaders called on them to continue with their conservation commitments in deference to their own cultural and ecological values, and out of respect for the conservation contracts they had collectively signed. Despite household disgruntlement over the lack of payments, 67% of the households still thought that the program would comply with its promises and 62% continued to believe that the program of conditional payments was fair. Thus, it is possible that some households continued to comply in part due to their intrinsic commitment to conservation of their collective lands and respect for their communal governance arrangements, and in part, with the hope that PSB would ultimately fully repay them and make continued payments, so long as the households continued with their contractual obligations.

Lastly, it is important to recognize how PSB may be interacting with broader land-use transitions occurring in the highlands of Ecuador and other parts of the Andes (Jampel, 2016; Taboada et al., 2017). As seen in figure 4, across all study communities grazing in the collective páramos has declined over the past ten years, nonetheless, the reduction has been significantly greater in PSB communities.

While there are a number of factors that contribute to the overall decline in páramo use (Taboada et al., 2017), our results suggest that PSB restrictions, and the subsequent payments may be contributing to the transition away from cattle suited to high elevations to other livelihoods. Across the Ecuadorian Andes, there has been a gradual shift toward dairy cattle (Jampel, 2016). Our preliminary evidence suggests that PSB restrictions and payments may be supporting a shift away from extensive highland grazing toward dairy farming at lower elevations. This has been particularly true in communities C and D where the average number of cows a household owns has increased since enrolling in PSB, yet overall, grazing has significantly declined in the collective lands. Here, communities have invested part of the incentive in improved pasturelands, breeds of dairy cattle, and in collection centers for milk. Similarly, communities are looking for other ways to benefit from their collective lands. Communities A, C, D and E have also used part of the funds to support ecotourism activities, although it is not clear yet the success of these initiatives. More research is needed to better understand how participation in PSB is supporting these livelihood transitions and changes in land-use habits.

6. Conclusions

The findings indicate that even with payment loss and future uncertainties, households continue to comply with land-use restrictions. DID results show that since its inception, PSB has produced on average, an additional 20% decrease in grazing across households in participant communities when compared to the control. While the most significant reductions occurred during the initial years when payments happened as scheduled (2008-2013), the reduction in grazing continued even when payments stopped between 2015-2017 and in a context where continued payments remained uncertain. Thus, while there is evidence that PSB and its associated conditional payment prompted a change in land-use behavior, the removal of PES payment did not result in a return to the initial land-use behaviors. The findings suggest that contrary to fears that PES programs may produce a ‘no pay, no care’ mentality, households continued to conserve their communal lands, irrespective of payments.

In accordance with the literature on non-monetary or relational benefits from PES (Bremer et al., 2018), our exploratory findings support the link between continued compliance and program alignment with non-economic benefits derived from participation, namely the perceived programmatic support of local institutional arrangements to govern collective lands. Particularly in the context of collective PES, the finding indicate how conditional payment programs can prompt sustained behavioral change and support collective action for more permanent resource management arrangements (Ezzine-de-Blas et al., 2019; Muradian, 2013). For policymakers and practitioners working in collective settings, these findings further highlight the importance of understanding how a community perceives PES and illustrate how the rule-making processes associated with collective PES contracts can be a critical building block for sustained success.

Findings also suggest that time and the broader transitional context may play an important role in habit breaking and habit making (Hiedanpää & Bromley, 2014). Here we see how a household’s sustained land-use changes may depend on other socioeconomic and biophysical trends in the region. In the case of our highland communities, we find evidence that PES has supported the switch to dairy cattle, and the development of ecotourism facilities; transitions that were already occurring in the region. The research indicates the importance of recognizing time in shaping behavior and cautions against relying solely on framed field experiments and stated behavioral changes to hypothetical future conditions as they are limited in their ability to capture the contextual conditions that may influence future decisions.

Finally, our study points to the need for more research to identify how communal, household and contextual conditions influence the longstanding success of PES. First, as noted, given our small sample we are limited in our ability to test how different household and communal factors may influence response to loss of payment given first the high degree of continued compliance. In particular, we need more information on how communal governance attributes may work to sustain the land-use restrictions. Collective PES is unique in that the contracts often demand that communities engage in collective action to develop and monitor new land-use rules, and distribute the economic incentive across community members (Hayes et al., 2019). Our earlier work found that communal organization was instrumental in creating and strengthening land-use rules under PSB and in attaining household compliance during the first years of program implementation (Hayes et al., 2015; 2017). In our research, we found no evidence that communities relaxed their land-use rules once payment stopped. More research is needed, however, to understand the communal conditions in which new land-use arrangements endure, and when they collapse, if payments stop.

At the household level, we need to understand the impact of payment loss on households, particularly vulnerable populations. From a compliance perspective, our results show no evidence that loss of payments produces an increase in use or return to previous land-use behaviors. We note however, that many PES programs, like PSB, intend to promote conservation and community well-being. Our preliminary results indicate that loss of payments has been particularly painful for households that rely on those payments for their basic necessities and for communities that were using the payments for transitions to alternative livelihoods. We encourage future studies to consider the socioeconomic implications of payment loss.

We also encourage scholars to examine the link between stated motivation and behavior as the role of intrinsic motivation in determining behavior is still undetermined and may be very context specific (Andersson et al., 2018; Gneezy et al., 2011). While our findings indicate a disjuncture between stated motivation and actual behavior, we are wary of how loss of motivation and trust may play out over longer time periods and could ultimately impact behavior.

Finally, we call for more case study comparisons across programs. If perceptions of a program as controlling or supportive due in fact influence the likelihood that behaviors are sustained, we need to understand how specific programmatic attributes drive these perceptions. The findings from the highlands of Ecuador suggest that PES program can sustain behavioral change. The next steps are further understanding the specific conditions that produce these enduring changes.

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Table 1. Community characteristics

	Participant Communities						Non-participant Communities				
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Intervention (# years)	8	8	9.5	8	7.5	10	NA	NA	NA	NA	NA
Payment ($/year)	37,735	11,414	25,523	11,379	16,671	16,872	NA	NA	NA	NA	NA
Páramo Size (Ha)	3,500	1,079	1,387	419	823	1,370	2,690	1,170	1,150	564	700
# Households	48	17	179	120	30	450	26	45	418	33	216
HH interviewed 2018	26	13	68	67	16	69	16	38	69	22	68
% interviewed	54	76	38	56	53	15	62	84	17	67	31
Wealth index 2018[a]	-0.56	-2.428	0.394	0.914	-0.506	-0.522	-1.153	-1.634	0.742	-0.157	-1.868
Poverty (%)[b]	85	99	95	85	85	93	93	85	95	85	85
Organization index 2018[a]	-0.177	1.367	-1.021	3.38	0.009	-0.349	0.332	0.689	1.29	-0.116	-0.567

[a] See Table 2 for variable definition. [b] Percentage of population living in poverty in the Parish where community is located (INEC, 2013)

Table 2. Description of variables

Variable	Variable construction
Outcome	
Graze in 2018	Report by head of household whether the household grazes cattle or sheep in the communal páramo in 2018. Dichotomous, coded with Yes ==1, if the household was grazing in 2018
Graze in 2013	Report by head of household whether the household grazes cattle or sheep in the communal páramo in 2013. Dichotomous, coded as Yes if the household was grazing in 2013
Graze in 2008	Report by head of household whether the household grazed cattle or sheep in the communal páramo in 2008 (recall question). Dichotomous, coded as Yes if the household was grazing in 2008
Household attributes	
No. of cows	Report by head of household on the total number of cows that a household owns.
Area pasture	Report by head of household on the total number of hectares of páramo that a household holds.
Wealth index	Household wealth level based on report by head of household of having: 1) electricity, 2) running water, 3) flush toilets, 4) vehicles, 5) motorcycles, 6) television, 7) gas stoves, and 8) cement floors. Using principal component analysis, the 8 variables were weighted with the first component vector of each normalized variable. The index has mean 0, and ranges from -2.41 to 2.53 (Hayes, et al. 2015).
Distance to páramo	Report by head of household on the minutes walking from house to closest edge of páramo.
Age	Head of household age in years
Perception páramo	Report by head of household whether he/she perceives environmental benefits (i.e. water provision, biodiversity) from having a páramo. Dichotomous, coded as Yes if he/she perceives environmental benefits.
Contextual factors: formal institutions	
PSB (Program Socio Bosque)	Dichotomous variable coded as Yes, if the household resides in a PES participant community, and No if resides in a non-participant community.
Contextual factors: communal governance	
Self-organization index	Community organization level based on: 1) # of communities' assemblies per year, 2) # *mingas* (traditional communal work) per year, and 3) if there are monetary sanctions for members that don't assist to assembly meetings. Using principal component analysis, the 3 variables were weighted with the first component vector of each normalized variable. The index has mean 0, and ranges from -1.65 to 3.68 (Hayes, et al. 2015).
Perceive catch	Report by head of household whether he/she perceives if it is likely that someone would be caught if the person does not obey a communal rule regarding the use of páramo. Dichotomous, coded as Yes if he/she perceives that someone is likely to get caught
Contextual factors: biophysical	
Population density	No. of households in a community per hectare of páramo that a community collectively holds.

Table 3: Differences-in-differences results of the effect of participating in PSB on grazing outcomes.

	Comparing 2008-2018		Comparing 2008-2013		Comparing 2013-2018	
	Coeff.	Std err.	Coeff.	Std err.	Coeff.	Std err.
Treat	-0.200	0.061***	-0.116	0.064*	-0.060	0.049
PSB	-0.027	0.052	-0.033	0.052	-0.134	0.038***
Time	-0.325	0.050***	-0.314	0.049***	-0.009	0.044
Population density	-0.387	0.124***	-0.428	0.133***	-0.213	0.098**
No. of cows	0.016	0.005***	0.016	0.005***	0.019	0.005***
Area pasture	-0.009	0.010	0.000	0.009	-0.011	0.007
Wealth Index	0.013	0.016	0.006	0.017	-0.021	0.012*
Distance to páramo	0.052	0.034	0.119	0.042***	-0.012	0.027
Age	0.002	0.001	0.001	0.001	-0.002	0.001
Perception páramo	-0.100	0.032***	-0.112	0.034***	-0.086	0.025***
Self-organization	0.015	0.010	0.001	0.020	-0.011	0.007
Perceive catch	0.064	0.038*	-0.003	0.035	-0.031	0.029
Constant	0.545	0.069***	0.582	0.074***	0.347	0.060***
N	845		780		845	
Adjusted R-Squared	0.287		0.211		0.122	

Note: Dependent variable is Grazing. Errors are clustered at the community level. *, **, and *** indicates that the coefficient is significant at the 10%, 5% and 1% level respectively

Table 4. PES Payment per household and percentage of hh perceiving impacts of payment loss

Participant Communities	A	B	C	D	E	F
Payment per hh (US$)	786	634	130	38	476	34
Impact hh cash for basic necessities	62%	85%	4%	6%	38%	0%
Impact community projects	4%	85%	28%	42%	25%	10%
Impact motivation to conserve	35%	62%	15%	15%	25%	3%
Impact trust of PES program	65%	69%	37%	37%	56%	4%
n	26	13	68	67	16	69

Figure 1. Case study location

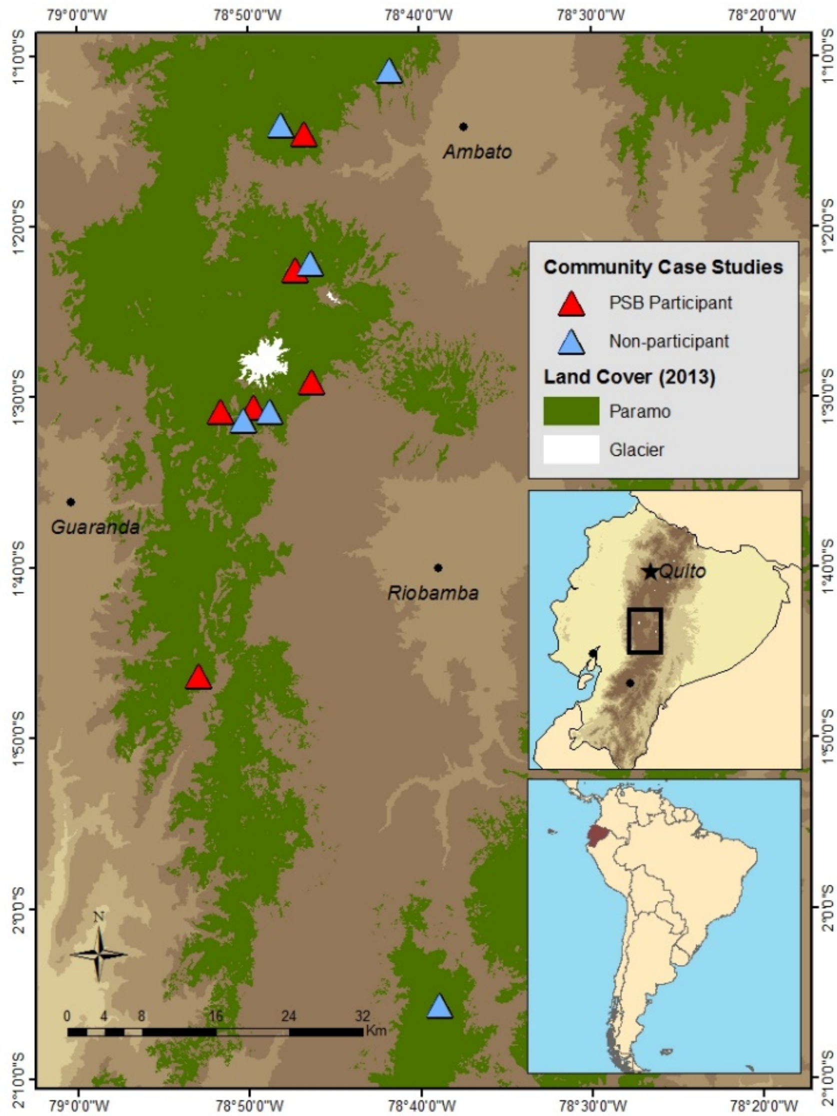


Figure 2. Adapted IAD framework to assess behavioral outcomes in PES

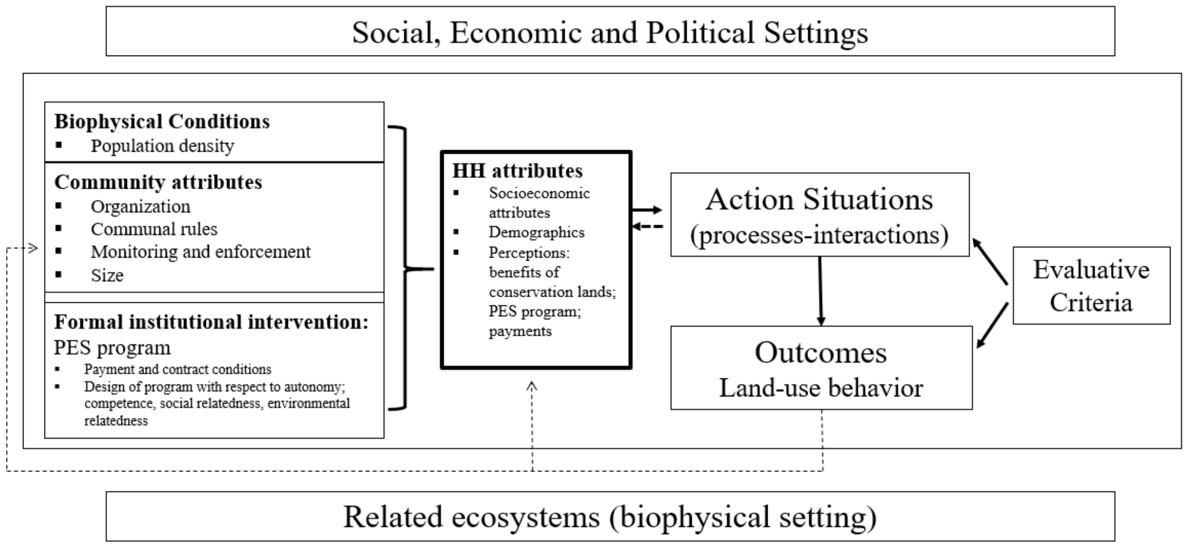


Figure 3. Percent of households grazing in communal lands

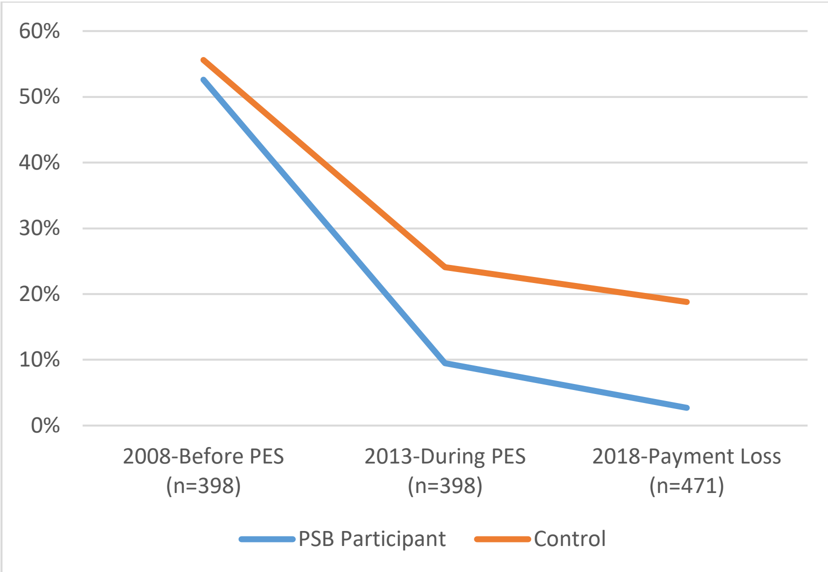
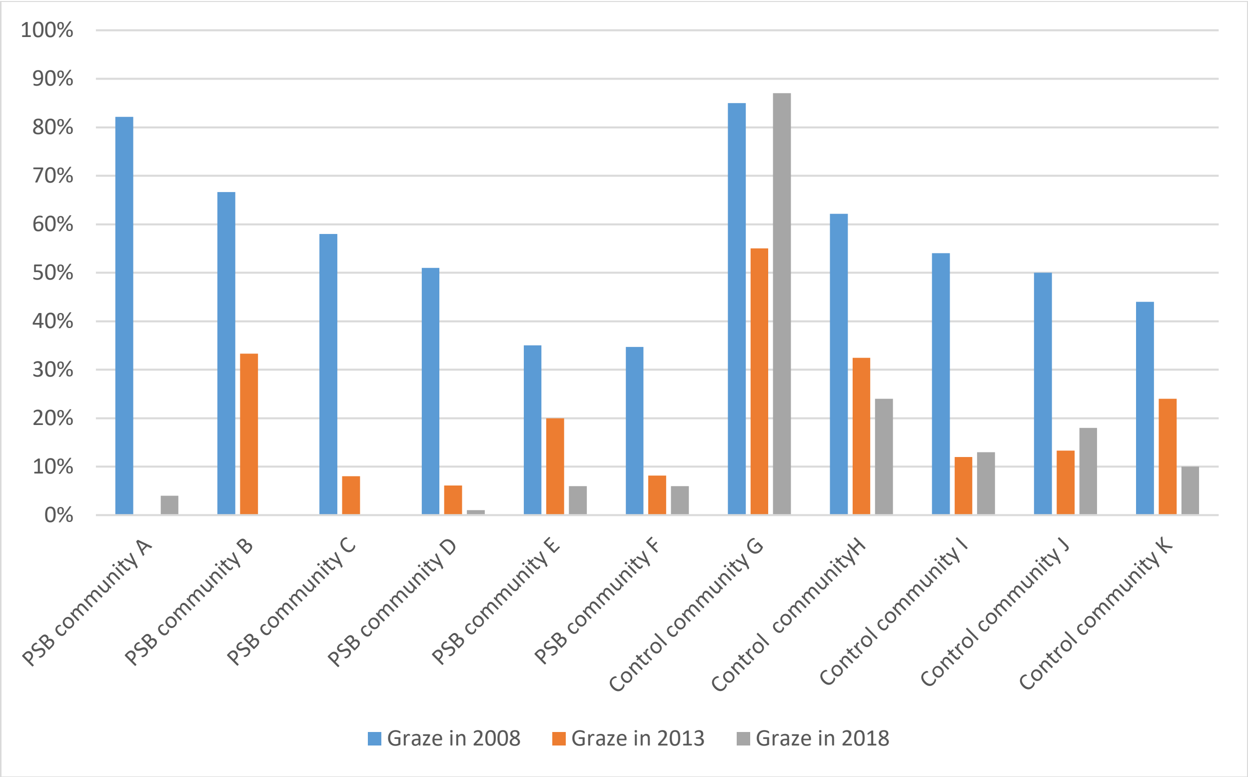


Figure 4. Percent of households that report grazing in 2008, 2013 and 2018 in the PES communities and control communities.



Appendix A.1. Community Level Characteristics in 2018. [9]

	PSB Participant Communities (n=6)					Non-Participant Communities (n=5)				
	Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD
No. of households	17	450	84	141	164	26	418	45	147	170
Páramo size (ha.)	419	3500	1225	1430	1077	564	2690	1150	1255	846
Population density (households/páramo)	0.01	0.29	0.07	0.13	0.13	0.01	0.43	0.06	0.17	0.19
Self-organization Index	-1.02	3.38	0.08	0.58	1.58	-0.58	1.29	0.33	0.32	0.72
Monitoring and enforcement (1=yes)	0	1	0.00	0.17	0.41	0	1	0.00	0.40	0.55
Rule history (1=yes)	0	1	0.50	0.50	0.54	0	1	1.00	0.60	0.54

[9] We analyzed both páramo size and community size separately, however, in the final regressions only population density is used as community size was found to be highly correlated to several other independent variables. Similarly, we analyzed monitoring and sanctioning mechanisms and perceived catch separately in the analysis and both returned similar results. In the final regressions perceived catch is used due to issues of multicollinearity.

Appendix A.2. Household Level Characteristics in 2018

	PSB Households (n = 259)					Non-participant Households (n = 213)				
	Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD
Graze in 2018 (1=yes)	0	1	0	0.03	0.16	0	1	0	0.19	0.39
Graze in 2013 (1=yes)	0	1	0	0.09	0.29	0	1	0	0.24	0.43
Graze in 2008 (1=yes) [10]	0	1	1	0.53	0.50	0	1	1	0.56	0.50
No. of cows	0	25	3	3.47	3.39	0	25	2	2.72	3.63
Area pasture (ha.)[11]	0	10	0.71	1.43	1.91	0	6	0.50	0.76	1.06
Wealth Index	-2.69	2.12	0.07	0.17	1.01	-2.49	2.12	-0.42	-0.11	0.81
Close to páramo (1=yes)	0	1	0	0.27	0.44	0	1	0	0.24	0.43
Age	16	84	47	47.0	14.7	16	79	45	45.4	15.2
Perception env benefits páramo (1=yes)	0	1	1	0.53	0.50	0	1	1	0.79	0.41
Perceive catch (1 = yes)	0	1	0	0.18	0.38	0	1	0	0.10	0.31

[10] Please note that there is no association between PSB participation and Graze in 2008 (X^2= 0.361, p =0.548, n=398).

Appendix B: Differences-in-Differences Communities Effect.

	Comparing 2008-2018		Comparing 2008-2013		Comparing 2013-2018	
	Coeff.	Std err.	Coeff.	Std err.	Coeff.	Std err.
Treat	-0.243	0.076***	-0.180	0.078**	-0.169	0.060***
PSB	-0.033	0.052	-0.035	0.052	-0.135	0.038***
Time	-0.319	0.051***	-0.314	0.049***	-0.009	0.045
Population density	-0.530	0.152***	-0.519	0.179***	-0.402	0.123***
No. of cows	0.017	0.005***	0.015	0.005***	0.020	0.005***
Area pasture	-0.009	0.010	-0.001	0.009	-0.008	0.007
Wealth Index	0.010	0.016	0.010	0.017	-0.024	0.012*
Distance to páramo	0.051	0.034	0.125	0.043***	-0.015	0.027
Age	0.001	0.001	0.001	0.001	-0.002	0.001*
Perception páramo	-0.107	0.032***	-0.111	0.034***	-0.091	0.025***
Self-organization	0.028	0.023	0.010	0.031	-0.028	0.016*
Perceive catch	0.077	0.039*	0.022	0.038	-0.014	0.030
Community B	-0.156	0.063**	0.181	0.138	-0.069	0.050
Community E	-0.015	0.075	0.135	0.111	0.064	0.073
Community F	0.210	0.056***	0.147	0.083*	0.223	0.049***
Community A	-0.056	0.036	-0.114	0.056**	-0.016	0.029
Community D	-0.012	0.112	0.079	0.091	0.186	0.081**
Constant	0.586	0.072***	0.598	0.079***	0.400	0.062***
N	845		780		845	
Adjusted R-Squared	0.295		0.215		0.136	

Note: Dependent variable is Grazing. Errors are clustered at the community level. *, **, and *** indicates that the coefficient is significant at the 10%, 5% and 1% level respectively