



The practice of Payments for Ecosystem Services (PES) in the Tropical Andes: Evidence from program administrators

Jonathan Bauchet^a, Nigel Asquith^b, Zhao Ma^{c,*}, Claudia Radel^d, Ricardo Godoy^e, Laura Zanotti^f, Diana Steele^c, Benjamin M. Gramig^g, Andrea Estrella Chong^h

^a Division of Consumer Science and the Center for the Environment, Purdue University, 812 West State Street, West Lafayette, IN 47907, United States

^b Cuencas Sustentables, Calle Rio Totaitu 15, Santa Cruz, Bolivia

^c Department of Forestry and Natural Resources and the Center for the Environment, Purdue University, 195 Marsteller Street, West Lafayette, IN 47907, United States

^d Department of Environment and Society and the Ecology Center, Utah State University, 5200 Old Main Hill, Logan, UT 84322, United States

^e The Heller School for Social Policy and Management, Brandeis University, 415 South Street, MS 035, Waltham, MA 02453, United States

^f Department of Anthropology and the Center for the Environment, Purdue University, 700 W. State Street, Suite 219, West Lafayette, IN 47907, United States

^g Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, 312 Mumford Hall, 1301 W. Gregory, Urbana, IL 61801, United States

^h IMPAQ International, 1325 G St. NW #900, Washington, DC 20005, United States

ARTICLE INFO

Keywords:

Payments for environmental services
Market-based conservation
Conditionality
Conservation incentive
Social equity
Program implementation

ABSTRACT

Studies of Payments for Ecosystem Services (PES) have focused on the theory, design, and impact of programs while paying less attention to program implementation. We surveyed 18 administrators from 39 active PES programs across the Tropical Andes about their views on program design and implementation. We found that (1) all programs have both ecological and social goals, (2) few programs pay cash, (3) most programs' primary source of financial support are international organizations, (4) barriers to participation are perceived as behavioral more than economic, and (5) conditionality exists on paper in all programs but is seldom enforced. To explore the "why" behind these findings, we conducted follow-up key-informant interviews with administrators of Watershared, one of the largest in-kind conservation incentives programs in the region. Watershared's characteristics – dual goals, in-kind transfers, a focus on non-economic motivations, and compliance enforcement – are fundamental to its theory of change and sustainability. Together, these survey and interview results show how PES has been adapted and reinvented to fit different philosophies, institutions, and cultures across the Tropical Andes. Our work highlights the importance of collaboration between academics and PES practitioners for addressing the disparities between academically promoted design principles and on-the-ground implementation.

1. Introduction

Market-based conservation is increasingly popular: since the 1990s, contracts known as Payments for Ecosystem Services (PES) have spread worldwide, with 36–42 billion USD spent annually in programs implementing this approach (Salzman et al., 2018). PES has been the subject of considerable research, much of it focused on defining its key characteristics, formalizing the theory behind the concept, and inferring preferred program design features (e.g., Engel et al., 2008; Farley et al., 2011; Muradian et al., 2010; Nelson et al., 2020; Pagiola et al., 2005; Wunder, 2015; Wunder et al., 2018). A growing number of studies have examined PES program implementation on the ground,

often finding that implementation is distinct from the theoretical ideal and has been adapted to different settings (Bottazzi et al., 2018; Bremer et al., 2016; Goldman-Benner et al., 2012; Shapiro-Garza et al., 2020).

In this article, we contribute to this growing area of research that bridges theoretical approaches to PES and the way PES is actually practiced. We do so by building upon an emerging body of research in Latin America that assesses the effectiveness of PES programs (e.g., see Bremer et al., 2016; Martin-Ortega et al., 2013; Santos de Lima et al., 2019). Our effort complements recent reviews of PES programs (e.g., Salzman et al., 2018; Wunder et al., 2018) and work advocating for reconciling PES theory and practice (e.g., Goldman-Benner et al., 2012; Shapiro-Garza et al., 2020) by focusing solely on learning from program

* Corresponding author.

E-mail addresses: jbauchet@purdue.edu (J. Bauchet), nigelasquith@watershared.net (N. Asquith), zhaoma@purdue.edu (Z. Ma), claudia.radel@usu.edu (C. Radel), rgodoy@brandeis.edu (R. Godoy), lzanotti@purdue.edu (L. Zanotti), dianacsteele@gmail.com (D. Steele), bgramig@illinois.edu (B.M. Gramig), andrea.estrella.c@gmail.com (A.E. Chong).

<https://doi.org/10.1016/j.ecoser.2020.101175>

Received 11 March 2019; Received in revised form 31 July 2020; Accepted 8 August 2020

Available online 01 September 2020

2212-0416/ © 2020 Elsevier B.V. All rights reserved.

administrators about specific local implementations of PES and how they differ from academically established theories.

Our work builds on research by [Bremer et al. \(2016\)](#), which focused exclusively on PES programs that are part of the Latin American Water Funds Partnership. We extend beyond a single-resource focus (e.g., water) to assess a diversity of PES programs. Specifically, we assess the gaps between PES theory and practice in four tropical Andean countries (Colombia, Ecuador, Peru, and Bolivia) and identify lessons that could guide future PES program design and implementation. In doing so, we advance the finding that there are different ways of conceptualizing and practicing PES programs and that solely focusing on market-based design principles does not capture how PES programs are actually implemented.

2. Existing and emerging understanding of PES

There are various definitions of PES, and a variety of conservation programs have been described as “PES.” [Wunder \(2015, p. 241\)](#) provided an early definition of PES, widely used by academics and some international development agencies, as “(1) a *voluntary* transaction where (2) a *well-defined* Ecosystem Service (ES) (or a land-use likely to secure that service) (3) is being ‘bought’ by a (minimum one) ES *buyer* (4) from a (minimum one) ES *provider* (5) if and only if the ES provider secures ES provision (*conditionality*).” Based on this specific definition, conditionality has been considered “the single defining feature” of PES ([Wunder, 2015, p. 234](#)), which differentiates PES from other environmental conservation programs that rely on *de facto* transfers to owners of natural resources without obligating owners to change their behavior ([Ma et al., 2017](#)). In contrast, [Muradian et al. \(2010, p. 1205\)](#) defined PES far more broadly as “a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources.”

Related to the different definitions of PES, there have also been various philosophies regarding what PES programs should achieve. Some scholars believe the goal of PES should be to achieve efficient allocation of natural resources ([Engel et al., 2008](#); [Pagiola et al., 2005](#); [Wunder et al., 2008](#)), but others argue that PES should have both environmental and social goals ([Grieg-Gran et al., 2005](#); [Milder et al., 2010](#); [Muradian et al., 2010](#)). Starting in the late 2000s, the concept of pro-poor PES has gained popularity ([Muradian et al., 2010](#); [Pascual et al., 2010](#)). However, previous research has also documented the difficulties of using PES to achieve multiple policy goals simultaneously ([Alix-Garcia et al., 2015](#)).

Since the first formal definition of PES ([Wunder, 2005](#)) and the first evaluation of a PES program in Costa Rica ([Zbinden and Lee, 2005](#)), three aspects of PES have drawn the most attention: [i] the amount and quality of ecosystem services provided (e.g., [Fuentes-George, 2013](#); [Jackson and Palmer, 2015](#); [Muradian et al., 2010](#); [Pattanayak et al., 2010](#); [Persson and Alpizar, 2013](#); [Pynegar et al., 2018](#); [Sommerville et al., 2009](#); [Wunder, 2015](#)); [ii] measures of direct and indirect impacts on participants (e.g., [Jayachandran et al., 2017](#); [Wiik et al., 2019](#); [Wunder et al., 2008](#)); and [iii] the social equity implications of the programs (e.g., [Adhikari and Agrawal, 2013](#); [Corbera et al., 2007](#); [Grillos, 2017](#); [Kolinjivadi et al., 2015](#); [Lansing, 2014](#); [Milne and Adams, 2012](#); [Pascual et al., 2014](#); [Rodríguez de Francisco et al., 2014](#)).

As the PES concept has spread worldwide, many programs have been tailored to local or regional institutional and social-ecological contexts, resulting in a diversity of ways in which the concept has been implemented. However, there is a limited understanding of these adaptations. Given the challenge of keeping up with local adaptations and innovations of PES, scholars have focused on documenting the implementation of PES programs, such as the type of ecosystem services being generated, the characteristics of buyers and sellers, and how payments are financed (e.g., [Dillaha et al., 2007](#)). The work by Forest Trends is likely the most comprehensive of such efforts. Beginning in

2010 ([Stanton et al., 2010](#)), Forest Trends has conducted a global survey of several hundreds of private and public watershed investment programs including PES programs in about 60 countries (number of programs surveyed and countries covered varied from year to year) and has produced a series of *State of Watershed Payments* and *State of Watershed Investment* reports that analyze global and regional trends in the scale, scope and direction of innovative finance for watershed services. [Bennett and Ruef \(2016\)](#) is the latest report in the series.

In this article, we evaluate on-the-ground program realities based on the perspectives and experiences of program administrators. As [Santos de Lima et al. \(2017\)](#) pointed out, PES administrators often have a wealth of knowledge regarding the practical constraints of using PES to achieve conservation outcomes; however, their views and knowledge are “frequently disregarded by theorists and decision makers proposing top-down policies” (p. 143). We focus on program administrators as the key actors who can provide institutional insights on program design and adaptation, particularly related to the appropriateness of program design, its links to outcomes, and the gap between theory and practice. The viewpoints of program participants would add an even more comprehensive understanding of PES implementation (e.g., [Alarcon et al., 2017](#); [Bremer et al., 2014](#); [Hegde et al., 2015](#); [Lansing, 2017](#)), but such a goal lies beyond the scope of this article.

Specifically, we rely on a survey of PES program administrators. We include under the term “PES” programs in which owners of natural resources (individually or as a community) receive cash payments or in-kind transfers if they agree to binding requirements about how to manage their resources to produce ecosystem services ([Engel et al., 2008](#); [Norgaard, 2010](#); [Wunder, 2005](#); [2013](#); [2015](#)). In-kind transfers might consist of resources such as tree seedlings, beehives, or irrigation pipes. This definition allows us to include in our survey programs that originated from or relate to a PES approach but have diverged in substance or philosophy from the [Wunder \(2005\)](#) definition. In the next section, we detail how we have attempted to assess on-the-ground program realities and the rapidly changing landscape of PES programs through a survey of program administrators in four Andean countries.

Informed by a comprehensive literature review, we identified five areas of PES program design and implementation as the focus of our research. These areas emerged as potentially divergent from the way PES has been defined and used in much of the academic literature and by some international development agencies ([Wunder, 2015](#)). Hence, our research was designed to learn more, from an administrator perspective, about:

- 1) program goals,
- 2) payment modalities (i.e., cash vs. in-kind),
- 3) program sustainability, particularly with respect to funding sources,
- 4) participation decision-making, and
- 5) conditionality.

3. Research motivation and hypotheses

By definition, the original **program goals** of PES focused on improving environmental quality. However, concerns about social equity have grown, and many now feel that PES programs should have dual goals centered on conservation and improving the socioeconomic status of participants. Indeed, there is disagreement about whether PES should be a mechanism for both conservation and development or focus on provisioning ecosystem services ([Farley et al., 2011](#); [Kolinjivadi et al., 2015](#); [McAfee and Shapiro, 2010](#); [Van Hecken and Bastiaensen, 2010](#); [van Noordwijk and Leimona, 2010](#); [Wunder, 2005](#); [2008](#)). Given that a single policy mechanism may not be able to address multiple problems efficiently ([Tinbergen, 1952](#)), it may be that “multiple non-environmental side objectives and social equity concerns” lead to “simplifying shortcuts in design and implementation” of PES programs “thus underperforming their conservation potential” ([Wunder et al., 2018, p. 145](#)). We wanted to understand if administrators had empirical

evidence to suggest that a program with two goals may ultimately achieve neither.

In the broader literature about transfer programs for promoting human development and reducing poverty, there has been a long debate regarding the **modalities of payments, namely cash versus in-kind transfers** (Currie and Gahvari, 2008; Gangopadhyay et al., 2015). From a purely economic perspective, cash is easily convertible and, hence, more flexible and less paternalistic than in-kind transfers (Engel, 2016; Robertson and Wunder, 2005; Wunder, 2008; Wunder et al., 2005). However, Kerr et al. (2014) show that, compared with cash payments, in-kind transfers are less likely to be perceived as external actors interfering with how communities manage their natural resources and thus less likely to erode intrinsic motivations for conservation. This may make such programs more sustainable. In-kind transfers also may be less susceptible to corruption and theft (Aker, 2013; Devereux and Vincent, 2010; Kerr et al., 2014; Kolinjivadi et al., 2015). In the case of community-based programs, in-kind transfers are less excludable and have greater potential for benefitting entire communities (Sommerville et al., 2010), but may lead to free-riding (Porras et al., 2013).

While PES was conceptually designed to be self-sustaining, we wanted to assess what mechanisms administrators had put in place to ensure their **financial sustainability** with a focus on funding sources. In theory, PES is a “voluntary transaction between service users and service providers” (Wunder, 2015, p. 241). However, PES often involves public funds and government interventions that go beyond establishing and enforcing well-defined property rights to alter status quo private market outcomes (Fletcher and Breitling, 2012; McElwee, 2012; Pirard, 2012; Schomers and Matzdorf, 2013; Shapiro-Garza, 2013a; Wunder et al., 2005). While international grants have been pivotal in many PES start-ups, the conceptual expectation of PES is that service users should sooner or later displace international donors. Indeed, the PES moniker implies that programs should be entirely financed by users. We wanted to assess the extent to which PES programs are sustained by external donors rather than ecosystem service users (including local government and private entities that would purchase the ecosystem services for the ultimate end users).

A central PES debate assesses whether there are tradeoffs between environmental effectiveness, economic efficiency, and social equity and why potential participants may or may not sign up (Bremer et al., 2014; Farley et al., 2011; Gong et al., 2010; Osborne, 2015; Pascual et al., 2010; Swallow et al., 2009; Tacconi, 2012; Tallis et al., 2008; Wunder et al., 2018; 2005). Our **participation decision-making** questions focused on assessing whether administrators perceive barriers to participation as behavioral or economic. When the PES concept was initially developed, it was assumed that participation decision-making would focus on economic issues, but there is now growing evidence that other factors are at play, such as social embeddedness and community social norms (Grillos, 2017; Grillos et al., 2019). We wanted to know if PES administrators had considered this in their programs and if they thought potential participants were making their decisions based primarily on economic calculations.

Finally, we wanted to assess to what extent programs implemented **conditionality**, the supposed key feature of PES. Ma et al. (2017) underscored the potential adverse unintended impacts associated with conditional PES. Their concerns are shared by others who have argued that imposing conditions in PES programs can limit participation of marginalized groups even when they are eligible to participate (e.g., Bremer et al., 2014; Krause and Loft, 2013; Lansing, 2014; McAfee, 2012; Muñoz-Piña et al., 2008; Rodríguez et al., 2011; Vatn, 2010; von Hedemann and Osborne, 2016). From an administrator perspective, enforcing conditionality can be expensive—both the financial and human resource costs of monitoring and enforcement activities, and the potential political cost of penalizing infractions. Given that conditionality is purportedly “the single defining feature” of PES we wanted to determine if, in fact, administrators actually implement and

enforce conditionality.

In summary, motivated by the PES literature, we developed, pilot tested, and finalized a survey to elicit information from administrators related to the aforementioned five main areas of PES program design and implementation (a copy of the questionnaire is in [Supplementary Material A](#)). Although our survey questions were wide ranging, our analysis primarily focuses on addressing the following five hypotheses. The survey questions that were used to address each hypothesis can be found in [Supplementary Material B](#).

1. Most PES programs have not only environmental goals but also socioeconomic goals.
2. Most PES programs do not make cash payments but rather make in-kind transfers.
3. Most PES programs are not paid for by service users but are funded primarily by external donations or general taxation.
4. Potential “sellers” of ecosystem services do not base their participation decision purely on economic factors, but rather on a suite of economic and non-economic motivations.
5. Conditionality, the supposed “single defining feature” of PES, is rarely enforced.

4. Methods and data

4.1. Inventory of programs

We focused on programs in Colombia, Ecuador, Peru, and Bolivia for two reasons. First, the region is one of the world’s 36 “biodiversity hotspots”; these hotspots have many endemic plant species, are vulnerable to habitat loss, and are a priority for conservation (Mittermeier et al., 2011). Second, many PES programs have been implemented in the region (Bennett and Ruef, 2016). To create an inventory of all PES programs in the four countries, we first created an initial list of all PES programs that had been described and analyzed by previous research and that met our definition of a PES program, informed by a systematic review of literature. Subsequently, we conducted Internet searches to verify each of these programs’ current operation status and collect contact information.

We then conducted consultations with eight key informants to further verify the list of PES programs we had compiled and to help us identify additional PES programs for our survey. Key informants included program administrators and practitioners from each of the four countries and conservation experts from non-profit organizations (EcoDecisión, Forest Trends, and The Nature Conservancy) and the United Nations Development Programme. We identified these key informants based on their influence in the countries of our interest as well as their recent publications. Through this three-step process, we identified 62 possible programs, of which 40 were active at the time of our inventory. These 40 programs formed our population of PES programs for the survey.

4.2. Survey administration and key-informant interviews

The survey took place from August to October 2016. The survey was made available in both Spanish and English. Most response options were closed-ended, but we provided respondents with the option to expand on answers by using the option “Other, please specify.” We initially surveyed all administrators on-line using Qualtrics software, version August–October 2016 of Qualtrics. We defined an “administrator” as the responsible person in an organization in control of day-to-day program management. Administrators who did not respond after two weeks were reminded of the survey via email. Three weeks after the initial invitation, we followed up with telephone calls to those who had not responded. If, after three follow-up telephone calls, administrators still had not responded, we stopped reaching out. We guaranteed administrators confidentiality before administering the survey and

Table 1
Survey response rate by country.

	No. of PES programs identified to be active and subsequently invited to participate in the survey	No. of active PES programs that responded to the survey	Response rate by country
Colombia	8	3	38%
Ecuador	10	3	30%
Peru	20	11	55%
Bolivia	1	1	100%
Total	39	18	46%

recorded all responses anonymously.

One of the 40 programs we contacted was no longer in operation at the time of our survey, reducing our population to 39 programs. We received a total of 18 responses, making our effective response rate 46%. We received three responses from Colombia, three from Ecuador, 11 from Peru, and one from Bolivia (Table 1). When administrators oversaw more than one program in their organization, they were asked to consider the largest program when responding. We analyzed survey data using descriptive statistics in Stata 12.0. To analyze open text responses to the option of “Other, please specify,” we manually coded each text response by first distilling it into a brief description or phrase, then comparing the distilled description or phrase with the pre-defined list of options in the corresponding question, recoding the distilled description or phrase that was sufficiently similar to the pre-defined list of options, and adding new options representing distilled descriptions or phrases that did not resemble any option from the pre-defined list. By doing so, we were able to code all text responses to a question as numerical responses to pre-determined response options or new response options. This allowed us to analyze all survey data using univariate statistics.

After analyzing the quantitative data, we undertook further key-informant interviews with the administrators of Watershed (Acuerdos Recíprocos por Agua in Spanish), a program that is widespread across Bolivia and now replicated in Colombia, Ecuador, and Peru. Such qualitative analysis of the experiences of Watershed, one of the largest and well-studied in-kind conservation incentive programs in the region, helped us interpret our quantitative results and begin to explain the “why” of the patterns we had discovered in the other cases.

5. Results

Our results show some shared patterns across administrator responses but also point to differences in program objectives, design, and implementation. Reasons behind these differences are likely complex and shaped by the specific history and cultural and political contexts of each program. Differences in program age, location, and geographic scale point to these larger underlying differences among the surveyed programs. For example, respondents reported that, on average, their programs have been operating for seven years, but with a range of 2.3–16 years ($SD = 4.7$). Among the 18 programs, nine (50%) operate within one or several watersheds or micro-watersheds, three (17%) operate in multiple municipalities or districts within the same province or region, five (28%) operate in one or several provinces or departments, and one (6%) operates in watersheds around key cities in three countries. Turning specifically to our five hypotheses, the similarities and differences across programs further emerge. We describe key results below and include all descriptive statistics of the administrator responses in [Supplementary Material C](#).

Hypothesis 1.. Most PES programs have not only environmental goals but also socioeconomic goals. We asked administrators to identify reasons for the creation of their program; multiple answers were allowed. All respondents said their program was created to “protect the environment” (100%) and 15 programs (83%) were created to “promote sustainable use of natural resources.” A large majority of

programs also reported socio-economic goals: 14 administrators (76%) answered that their program aimed to “produce environmental services that benefit human societies” and 12 (65%) to “support the well-being of local communities beyond reducing poverty.” Eleven programs (61%) have explicit objectives to produce social outcomes as well as ecological outcomes.

The environmental services most commonly targeted by the programs are water quality (16 programs or 89%), biodiversity (13 or 72%), and forest cover (13 or 72%), while six (33%) programs sequester carbon, six provide scenic beauty, and six regulate water quantity. The social outcomes targeted by the programs tended to be broad, aiming to support the well-being of communities (11 programs, or 61%) rather than directly reduce poverty (five programs, or 29%). Some examples of intended social outcomes were provided by administrators as part of their open-ended responses, including generating sustainable farming, improving rural living conditions, and improving the quality of life of participants.

Most administrators perceived their programs having positive impacts on both environmental and socio-economic outcomes (Table 2). Biodiversity and forest cover were perceived to benefit the most from the programs, with all administrators reporting very positive or positive impacts on these outcomes. None reported negative impact on any environmental outcomes. In contrast, impacts on socio-economic outcomes were generally perceived to be less positive than impacts on environmental outcomes, with more administrators reporting “no impact” on each socio-economic outcome. For example, eight administrators (73%) reported that their program had no impact on the overall income inequality in participating communities. A majority of administrators also reported that their program had no impacts on the general well-being and financial situation of non-participants. It is worth noting that one administrator indicated a negative impact on local conflicts between participating and non-participating households. In an open-comment box, one administrator also expressed a concern that “*there is inequality in [our program’s] requirement of resources [needed to participate in the program], [leading to] widespread discouragement [among non-participants].*”

Hypothesis 2.. Most PES programs do not make cash payments but instead make in-kind transfers. Only one program (6%) used only cash. Thirteen programs (72%) provided only non-cash, in-kind transfers. Four programs (22%) provided both cash and in-kind transfers.

Hypothesis 3.. Most PES programs are not paid for by service users but are funded primarily by external donations or general taxation. Comparing international and domestic support for PES, 12 of 17 respondents (71%) said their program had multiple sources of funding in the past five years. The average number of sources of funding reported was 3.2 (range: 1–7; $SD = 2.1$). The following sources were commonly identified: international donors (14 programs, or 82%); domestic non-governmental donors (10 programs, or 59%); private local ecosystem service users (nine programs, or 53%); local governments that benefit from ecosystem services produced (eight programs, or 47%); and providers of drinking water, sewage treatment plants, and other private companies (six programs, or 35%). Only two administrators (12%) reported their program had

Table 2
Program administrators' perceptions of their program impacts on various outcomes.

	Very positive	Positive	No impact	Negative	Very negative	Total ^a
<i>A. Environmental outcomes</i>						
Biodiversity	4 (29%) ^b	10 (71%)	0	0	0	14
Forest cover	3 (21%)	11 (79%)	0	0	0	14
Carbon sequestration	1 (8%)	10 (77%)	2 (15%)	0	0	13
Water quality	6 (40%)	7 (47%)	2 (13%)	0	0	15
Scenic beauty or tourism	2 (15%)	9 (69%)	2 (15%)	0	0	13
Environmental quality in general	4 (27%)	11 (73%)	0	0	0	15
Various environmental services	3 (21%)	11 (79%)	0	0	0	14
Sustainable use of natural resources	1 (7%)	13 (87%)	1 (7%)	0	0	15
<i>B. Socio-economic outcomes</i>						
General well-being of participants	1 (8%)	12 (92%)	0	0	0	13
Financial situation of participants	1 (8%)	9 (69%)	3 (23%)	0	0	13
Gender inequalities in participating communities	0	8 (67%)	4 (33%)	0	0	12
Poverty reduction	0	7 (64%)	4 (36%)	0	0	11
Income inequality in participating communities	0	3 (27%)	8 (73%)	0	0	11
Conflicts between participating and non-participating households in local communities	0	3 (33%)	5 (56%)	1 (11%)	0	9
General well-being of non-participants	0	3 (33%)	6 (67%)	0	0	9
Financial situation of non-participants	0	2 (20%)	8 (80%)	0	0	10

^a Number of program administrators who responded for each outcome.

^b Number of responding administrators who checked a particular scale value, with the percentage in parentheses.

received funding from national governments.

Hypothesis 4.. Potential “sellers” of ecosystem services do not base their participation decisions purely on economic factors, but rather on a suite of economic and non-economic motivations. We asked program administrators to rank the reasons why they think some community members choose to enroll in their program and others choose not to. We offered respondents six choices for why community members join and seven possible reasons why they do not, with space for administrators to provide additional responses. Out of six possible reasons for joining, 13 of the 17 responding administrators (76%) ranked “to protect the environment” as the first or second reason motivating program participants, while ten (59%) ranked “to receive economic benefits” as the first or second reason (Table 3). Less than half of the respondents ranked the remaining reasons as the first or second reason. Four of the

responding administrators offered a write-in response about conserving water resources and ranked it as the first or second reason for enrollment.

Administrators' perceptions of why some community members do not enroll in their program varied (Table 3). Out of the seven possible reasons for potential participants not joining that were provided in the survey, eight of the 17 administrators (47%) ranked “They do not think they will be able to fulfill program requirements and conditions” or “They do not know how to change their current farming, animal-raising, or livelihood practices” as the first or second reason. Less than 30% of respondents ranked the remaining reasons as the first or second reason for not enrolling. Four of the 18 administrators also offered write-in responses as their first or second reason for not enrolling, including community members' distrust towards NGOs, local

Table 3
Program administrators' perceptions of the reasons why some community members do or do not enroll in their program.

Perceived reason for enrollment ^a	R1	R2	R3	R4	R5	R6	
To protect the environment	8(47%)	5(29%)	3(18%)	0(0%)	1(6%)	0(0%)	
To receive economic benefits	7(41%)	3(18%)	4(24%)	0(0%)	2(12%)	1(6%)	
Pressure from authorities	0(0%)	0(0%)	3(18%)	5(29%)	4(24%)	5(29%)	
Other members of their village/town/community are participating	0(0%)	3(18%)	2(12%)	7(41%)	5(29%)	0(0%)	
Their village/town/community signed up to participate as a whole	0(0%)	2(12%)	5(29%)	5(29%)	3(18%)	2(12%)	
Other reasons	2(12%)	4(24%)	0(0%)	0(0%)	2(12%)	9(53%)	
Perceived reason for non-enrollment ^b	R1	R2	R3	R4	R5	R6	R7
They are not eligible.	3 (18%)	1 (6%)	1 (6%)	3 (18%)	1 (6%)	2 (12%)	6 (35%)
They do not think they will be able to fulfill program requirements and conditions.	3 (18%)	5 (29%)	1 (6%)	3 (18%)	4 (24%)	1 (6%)	0 (0%)
They do not want to be penalized for not fulfilling program requirements and conditions.	3 (18%)	2 (12%)	3 (18%)	3 (18%)	2 (12%)	1 (6%)	3 (18%)
They do not want to change their current farming, animal-raising, or livelihood practices.	0 (0%)	2 (12%)	2 (12%)	4 (24%)	2 (12%)	5 (29%)	2 (12%)
They do not know how to change their current farming, animal-raising, or livelihood practices.	2 (12%)	6 (35%)	2 (12%)	3 (18%)	3 (18%)	1 (6%)	0 (0%)
It may be too much work or money for them to change their current farming, animal-raising, or livelihood practices	2 (12%)	1 (6%)	5 (29%)	0 (0%)	2 (12%)	4 (24%)	3 (18%)
Other reasons	4 (24%)	0 (0%)	3 (18%)	1 (6%)	3 (18%)	3 (18%)	3 (18%)

The number of valid responses is 17 because one administrator did not answer this question. R1 = number (and percentage) of respondents ranking a given response as most important, R2 = as second most important, and so on.

^a Six reasons for enrollment were provided to survey respondents to rank.

^b Seven reasons for non-enrollment were provided to survey respondents to rank.

governments, or business actors involved in the program; their lack of knowledge about the program; and insufficient program resources to compensate community members.

Hypothesis 5. Conditionality, the supposed “single defining feature” of PES, is rarely enforced. All 15 administrators who answered the question said that program participants were required to comply with conditions to receive payments. The conditions include adopting and maintaining conservation activities (e.g., revegetation, silvo-pastoral arrangements), avoiding prohibited activities (e.g., clear cutting, letting cows in streams), attending training sessions, and assisting the program with monitoring the properties of participants. Most administrators indicated that fulfilling these conditions required participants to invest labor (12 of 15 respondents; 80%) and spend time attending meetings and trainings (9 respondents; 60%), while three respondents (20%) reported the need for participants to invest their own money to fulfill program conditions.

In terms of compliance monitoring, 14 administrators reported that their program monitored participants’ compliance, while the other four administrators did not respond to this question. In all programs that monitored compliance, participants knew they would be monitored. The frequency of monitoring varied, including one program weekly, one monthly, two quarterly, one three times a year, three twice a year, and five once a year. One program was still deciding how often they would monitor compliance at the time of the survey. Monitoring was usually done by program staff in eleven (79%) programs, but five of the fourteen (36%) programs also had participants self-monitor, four (29%) were monitored by the government, and three (21%) were monitored by a management committee outside the program.

Responding to an open-ended question, program administrators identified several monitoring methods. Commonly used methods included on-site inspections, interviews with program participants, visits to participants’ homes or properties, and photographs of participants’ properties. Half of the programs used satellite images, water sampling, and hydrological monitoring of water quality and quantity. On average, administrators estimated that 13% of their total program costs were devoted to monitoring compliance with conditionality (range: 5–30%; SD = 9%).

Administrators whose program included conditionality thought participants did not have difficulty meeting conditions, estimating that 85% of participants, on average, had been able to meet conditions. Ten of the 12 responding administrators reported a compliance rate of 85% or higher, while one reported 25% and another reported 30%.

An important aspect of conditionality is the enforcement of conditions and any penalty for non-compliance. We asked survey respondents what penalty would occur if a participant failed to meet program requirements. Out of the 15 administrators who answered the question, four (27%) did not know or could not specify a penalty for non-compliance, but most reported that participants would suffer consequences for failing to fulfill their commitments. Specifically, ten respondents (67%) reported that participants would stop receiving payments if they failed to meet requirements, seven (47%) reported participants would lose eligibility to continue in the program, six (40%) reported that participants would be made known to their community for what happened, and three (20%) reported that participants would have to return previously-received payments.

Despite the reported potential repercussions for non-compliance, program administrators indicated that conditionality was often not enforced. More than half (6 of 11 respondents, or 55%) reported that no participants who had failed to meet conditions had been penalized. Only two out of 11 administrators (18%) reported that all non-complying participants had been penalized (formally or informally, temporarily or permanently), and three administrators estimated that 30%, 2%, and 1% of non-complying participants had been penalized.

To elucidate the “why” behind these general patterns, we interviewed administrators of Watershared. Currently, Watershared

conserves almost half a million hectares in five countries, having spread from Bolivia to Colombia, Ecuador, Mexico, and Peru (Asquith, 2016; Martinez et al., 2013). Although Watershared has an order of magnitude more land under conservation than the other programs we studied (Asquith, 2020), it shares a number of characteristics with them. Watershared has dual conservation and development goals (Bottazzi et al., 2018), incentives are almost entirely in-kind (Wiik et al., 2020), and service providers participate because of a suite of economic and non-economic motivations and constraints including financial incentives, individuals’ social capital, and community social norms (Grillos, 2017; Grillos et al., 2019). However, in contrast to the other programs, most of the costs of Watershared are paid by local governments and water users, and the program strictly enforces conditionality. Our key-informant interviews highlighted that most of these characteristics—dual goals, in-kind transfers, a focus on non-economic motivations, and compliance enforcement—have been present since program initiation in 2003, and crucially, all are fundamental to the program’s theory of change. Below we further discuss insights from Watershared, as well as how these insights help contextualize the survey results.

6. Discussion

Although ecological outcomes were a priority for the PES programs we studied, most programs had dual ecological and social goals, and the dual goals were reflected in program administrators’ own work. Our data suggest that dual ecological and social goals are widespread in the Andes and that “pure” PES is the exception rather than the rule. The administrators we surveyed and interviewed see themselves primarily as working to support communities, both in order to produce more ecosystem services, but also as a goal in itself. Watershared, for example, has evolved into its current form by recognizing how practices that degrade water quantity and quality (e.g., forest clearing and extensive cattle grazing) are inherent parts of people’s livelihoods and culture. The in-kind support packages are not of sufficient value to “buy” a specific amount of ecosystem services, but rather are designed to help ecosystem service providers transition to more environmentally and economically sustainable livelihoods. The Spanish language name for Watershared—Acuerdos Recíprocos por Agua—focuses on this reciprocal relationship between users and providers, and the program’s tagline demonstrates its dual goals: “Those who produce water, share it; those who benefit from water, share the benefits.”

Another finding from our study is that few PES programs paid cash. In-kind transfers were much more common than cash payments. However, the less prevalent use of cash payments may not mean they are less desirable. Indeed, in some contexts, cash payments are not used perhaps because they are not legal. Nevertheless, given the popularity of in-kind transfers in Andean PES programs, more work is needed to compare the environmental and socioeconomic effectiveness of cash payments versus in-kind transfers. Furthermore, practitioners need to exercise caution when providing in-kind transfers to communities, paying particular attention to choosing items that are culturally appropriate and that enable community members to further strengthen their conservation and livelihood practices (Cunha, 2014; Gangopadhyay et al., 2015). Bolivia’s Watershared program, for example, offers a menu of options for in-kind transfers, ranging from improvements in water access (e.g., plastic piping and taps), to honey production systems (beehives, smokers and protective overalls), to fruit tree seedlings. The menu also varies by context. For example, orange fruit tree seedlings are offered in the lowlands, and peach seedlings are offered at higher altitudes. The demand for in-kind transfers rather than cash payments came from participants in the pilot program. Because this modality has strong local support, it has never been changed since the initiation of Watershared.

The PES programs we studied tended to be supported by international rather than by domestic funding sources. In addition, in the previous five years, most programs had been supported by donors

(international donors for 82% of programs and domestic non-governmental donors for 59% of programs). In contrast, only about half of the programs had received funding from private local ecosystem service users or local governments, and only a third had received funding from local private businesses and entities (e.g., drinking water providers, sewage treatment plants). One of such programs is Watershared, with more than 60 municipal initiatives across Bolivia. Some, like the Comarapa Water Fund, are now entirely financed by local water users, but the full transition from donor support to service-user financing took ten years (Vargas et al., 2010). Our quantitative and qualitative results together suggest that although service-user-financed schemes epitomize the PES ideal, it is difficult for such markets to develop without subsidies. This raises serious doubts about if and how the PES schemes we studied can be sustainable. A period of donor subsidies for PES should perhaps be expected, but if sustainability is required, then a transition to service-user financing must be explicitly incorporated into a program's theory of change.

It is also noteworthy that only two of the programs we studied (12%) had received support from a national government. This contrasts with conditional cash transfer programs for schooling and health, which often count on national funding (e.g., Bedran-Martins and Lemos, 2017; Ma et al., 2017). This disparity may be because schooling and health rank higher than the environment among national priorities or present more clearly defined economic benefits, but it raises the questions of what role national governments should play in supporting PES and what is the ideal mix of market forces and government subsidies for the provisioning of environmental public goods.

Our study also shows that Andean PES program administrators perceived barriers to participation in PES programs to be largely behavioral rather than economic. It is possible that administrators' perceptions may not fully capture realities, as conservation professionals tend to assume that information and capacity are the key barriers to successful programs when other factors may in fact be more important (Owens, 2000). Within this context, our study identifies three perceived barriers to participation and highlights the need for empirical data on non-participation. First, almost half of the administrators thought that people may not know how to change their current farming, animal-raising, or livelihood practices. Second, an equal proportion of administrators perceived participants' fear of not being able to fulfill program conditions as a barrier to participation. A third perceived explanation for non-participation was distrust of NGOs, local governments, or businesses involved in the program, as identified and elaborated by several administrators in their write-in responses.

Our data do not allow for quantification of how widely trust is perceived as a barrier by all administrators, but other research suggests that community members may perceive PES programs as a way for outsiders to dictate what they can do on their land (Asquith et al., 2002; Hayes, 2012; Ostrom, 2003; von Hedemann and Osborne, 2016). A fundamental insight of Watershared administrators was that trust was the foundation of their entire program, and that the program would only be sustainable if they first built the trust of local service users and providers. Trust, catalyzed by having local institutions lead the initiative coupled with rigorous monitoring and enforcement, built service users' confidence that they should pay for the program. Meanwhile, service providers had evidence—in-kind support tailored to the local context and a clearly-stated development goal—that helped them trust that the program was considering their needs and not just focusing on the environment.

Trust-related concerns are not unique to PES programs; they have been identified as important in other conservation programs worldwide (e.g., Clarke et al., 2019; Graham and Rogers, 2017; Hayes, 2012; Rouleau et al., 2016; von Hedemann and Osborne, 2016). Many such programs have experimented with various collaborative, community-based approaches to build trust between their programs and communities, and a few have further experimented with signing PES contracts with communities instead of households (Blay et al., 2008; Cranford

and Mourato, 2011; Hayes et al., 2017; 2019). However, it is unclear to what extent signing contracts with communities rather than with households alleviates mistrust. Exploring reasons for non-participation in general, and mechanisms for how trust affects participation in particular, is a promising avenue for increasing participation in PES programs.

In the Andean PES programs we studied, conditionality exists on paper but is rarely enforced. Despite the prevalence of conditionality in program design, compliance monitoring is inconsistent. Even though the cost of monitoring is sizable (on average 13% of total program cost), sanctions for non-compliance are rare. These results mirror the findings of Wunder et al. (2018), regarding the enforcement of conditionality through a review of 70 PES programs across six continents. Wunder et al. (2018) observed that “the PES-defining principle of conditionality—monitoring compliance and sanctioning detected non-compliance—is seldom being implemented” and asserted that the lack of conditionality in practice is a potential explanation for why some PES programs are less environmentally effective.

In contrast to this general lack of enforcing conditionality, the Watershared administrators asserted that it is critically important to make an example of infractions to ensure that other participants continue to fulfill their commitments. In cases of gross non-compliance, in-kind transfers provided by Watershared were recovered from the infractor and redistributed back to the community (Wiik et al., 2019). The Watershared example also shows how a program can mobilize existing social norms and community mechanisms for enforcement, providing a positive feedback loop to promote compliance (Asquith, 2020).

Our study also suggests that PES administrators perceive that participants are joining their programs more for intrinsic environmental conservation reasons than for extrinsic economic gains. Thus, it may be that individuals, households, and communities can be more effectively persuaded to join and comply with a PES program by reinforcing their conservation-friendly intrinsic motivations, social norms, and cultures rather than using a carrot-and-stick conditional approach (Kerr et al., 2014; Nelson et al., 2020; Neumann, 2005; Robbins, 2012). In the case of Watershared, while barriers to participation in the program tended to be economic and social – households with formal land title, larger homes, more cattle, and stronger social connections showed higher uptake (Grillos, 2017), our study provides further evidence suggesting that social and cultural factors such as trust, social embeddedness, and length of time living in the community, not financial incentives alone, affect the overall participation in programs like Watershared (Grillos, 2017; Nelson et al., 2020).

Last but not least, making payments or transfers to some but not to all community members, may exacerbate inequality, create feelings of exclusion, and heightened perceptions of unfairness (e.g., Corbera et al., 2007; Muradian et al., 2010; Pascual et al., 2010; Sommerville et al., 2010; Vatn, 2010). Most administrators believed their programs improved ecological outcomes and generated social benefits for participants, but less than a third thought their programs benefitted non-participating households, and one administrator believed his program actually caused conflict between participating and non-participating households in the same communities (Table 3).

Overall, in addressing our five hypotheses, we have observed important variations of local implementations of PES. Even though PES is considered a market-based mechanism for environmental conservation in much of the academic and policy literatures, its implementation has been reinvented to fit philosophies of implementing organizations and local conditions, often deviating far from the idealized conditions that would enable a Coasean bargain in practice (Farley and Costanza, 2010; Muradian et al., 2010). These deviations and different program foci are notably reflected in the wide range of labels given to programs by implementing organizations.

As important, schemes that were originally conceptualized as PES have seen radical adaptations and innovations since their initiation. One example is the Water Fund (Fondo de Agua) approach. Water Funds are

mechanisms through which “water users voluntarily invest money in a trust fund, and the revenue from it is used to initiate conservation projects in the watershed” as well as livelihood enhancement projects and environmental education programs at the local scale (Goldman et al., 2010, p. 4). It is easy to trace the connection between the Water Funds approach and the original PES model. However, the models have since diverged in that Water Funds do not shy away from involving public agencies and organizations to build broad coalitions and leverage public funds for the provisioning of watershed-based ecosystem services (Bennett and Ruef, 2016).

In contrast, even though Bolivia's Watershed program was initiated under the PES banner (Asquith et al., 2008), its theory of change has never followed a neoclassical economic model. The original pilot in the Los Negros watershed has been widely cited in the academic literature (e.g., Bétrisey and Mager, 2014; Kemkes et al., 2010; Robertson and Wunder, 2005; Wunder, 2008), but even this original donor-funded scheme no longer operates as described by Asquith et al. (2008). In response to lessons learned from experimentally piloting different innovations, it was adapted and replaced by a new program (Watershed), which builds on local intrinsic motivations of reciprocity and co-responsibility (Bottazzi et al., 2018; Grillos, 2017; Pynegar et al., 2018; Wiik et al., 2019).

Finally, our study faced two limitations. First, although the number of programs included in our study was comparable to that in previous reviews and inventories (Bennett and Ruef, 2016; Samii et al., 2014; Wunder et al., 2018), we may have missed some programs. However, with responses from 46% of all identified programs in our area of study, we are confident that insights from the survey have external validity for the Tropical Andes. Second, we did not ask about change and innovation over the life of the programs, so we have only a snapshot of these programs at the time of the survey. Our qualitative analysis of the Watershed program, however, includes its evolution, partially addressing this limitation.

7. Future research directions and conclusions

Several areas for future research emerged from administrators' perspectives on PES programs. First, the tension between ecological and social objectives could be better addressed by measuring the ecological and socioeconomic impacts of PES programs, focusing on both intended and unintended outcomes at multiple scales. Recent evaluations of PES programs using randomized-controlled trials (e.g., Asquith, 2020; Jayachandran et al., 2017; Pynegar et al., 2018; 2019; Wiik et al., 2019) represent a welcomed first step. Second, we need more research on the cost-effectiveness of conditionality in PES programs. In randomized-controlled evaluations of programs that pay households to send their children to school, researchers have found that conditional and unconditional cash transfers often have similar impacts (Baird et al., 2014; 2013; Robertson et al., 2013). The third area for future research concerns the impacts of PES programs on community inequality, especially the impacts within and across households and communities, and possible spillovers.

The information we gathered from PES program administrators in the Andes leaves us with a number of important considerations. First, it may not be appropriate or accurate to describe programs that have dual ecological and social goals as “environmental.” Second, programs that provide in-kind transfers, often coupled with capacity building, may not be best described as employing a market-based conservation mechanism. Third, given that many programs do not enforce conditionality, this may not actually be a key feature of PES. Finally, a payment provided (practically) unconditionally by an international donor may not be best described as compensation for “services.”

The PES programs we studied were clearly not being implemented to comply with the “design principles pre-identified [...] as desirable” (Wunder et al., 2018, p. 145). Should practice be modified to reflect theory and to preserve the theoretical integrity of PES, or should theory

be adapted based on current program practices? Instead of continuing to conceptualize PES based on theoretical optimization, we propose a bottom-up approach to advancing PES theory based on program practices. A collaboration between academics and PES practitioners might provide a promising avenue to address some of the disparities between academically-promoted design principles and on-the-ground implementation (Asquith, 2020).

Declaration of Competing Interest

A co-author previously held a position in one of the organizations that responded to our survey. This same co-author also was involved with the development and initiation of Watershed and conducted the key-informant interviews with Watershed administrators. We do not believe this affected our work reported in this manuscript but want to disclose this fact for transparency. Although this is a potential conflict of interest, other independent co-authors co-designed the interview questions and together interpreted the interview results.

Acknowledgements

We thank Lourdes Barranco-Cortés for assisting in survey administration. We are grateful for all program administrators who took time to respond to our survey. We also thank the following individuals for reviewing drafts of our survey instrument, providing feedback to our inventory of PES programs in our study area, and helping us better understand the reality of program implementation: Alejandro Calvache from The Nature Conservancy (TNC) Colombia; Silvia Benítez and Jaime Camacho from TNC Ecuador; Jensen Montambeault from TNC's Science for Nature and People Partnership, USA; Marta Echavarría from EcoDecisión Ecuador; Genevieve Bennett from Forest Trends, USA; Oscar Zapata from the University of Regina, Canada; Marcela Quintero from the International Center for Tropical Agriculture (CIAT), Colombia; Amy Rosenthal from the McArthur Foundation, USA; Roger Loyola from the Ministry of Environment of Peru; Maria Teresa Vargas from Fundación Natura Bolivia. This study would have not been possible without the help from all these individuals. We are grateful for the helpful comments and suggestions by three anonymous referees. This research was supported by a seed grant from Purdue University's Center for the Environment, USA. Analysis and manuscript development were also supported by an award from National Science Foundation's Geography and Spatial Sciences (GSS) Program, USA (#1660481).

Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ecoser.2020.101175>.

References

- Adhikari, B., Agrawal, A., 2013. Understanding the social and ecological outcomes of PES projects: a review and an analysis. *Conserv. Soc.* 11 (4), 359–374. <https://doi.org/10.4103/0972-4923.125748>.
- Aker, J., 2013. Cash or coupons? Testing the Impacts of Cash versus Vouchers in the Democratic Republic of Congo. Center for Global Development Working Paper 320. Retrieved from < www.cgdev.org/sites/default/files/Aker-Cash-versus-Vouchers_0.pdf > .
- Alarcon, G.G., Fantini, A.C., Salvador, C.H., Farley, J., 2017. Additionality is in detail: Farmers' choices regarding payment for ecosystem services programs in the Atlantic forest, Brazil. *J. Rural Stud.* 54, 177–186. <https://doi.org/10.1016/j.jrurstud.2017.06.008>.
- Alix-Garcia, J.M., Sims, K.R.E., Yañez-Pagans, P., 2015. Only one tree from each seed? environmental effectiveness and poverty alleviation in Mexico's payments for ecosystem services program. *Am. Econ. J.: Econ. Policy* 7 (4), 1–40. <https://doi.org/10.1257/pol.20130139>.
- Asquith, N.M., 2016. Watershed: adaptation, mitigation, watershed protection and economic development in Latin America. Inside Stories on Climate Compatible Development. INSIDE STORIES on Climate Compatible Development. Climate and Development Knowledge Network (CDKN), London, UK.
- Asquith, N.M., 2020. Large-scale randomized control trials of incentive-based

- conservation: what have we learned? *World Dev.* 127. <https://doi.org/10.1016/j.worlddev.2019.104785>.
- Asquith, N.M., Vargas, M.T., Wunder, S., 2008. Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. *Ecol. Econ.* 65 (4), 675–684. <https://doi.org/10.1016/j.ecolecon.2007.12.014>.
- Asquith, N.M., Vargas Ríos, M.T., Smith, J., 2002. Can Forest-protection carbon projects improve rural livelihoods? Analysis of the Noel Kempff Mercado climate action project, Bolivia. *Adapt. Strat. Glob. Change* 7 (4), 323–337. <https://doi.org/10.1023/A:1024712424319>.
- Baird, S., Ferreira, F., Özler, B., Woolcock, M., 2014. Conditional, unconditional and everything in between: a systematic review of the effects of cash transfer programmes on schooling outcomes. *J. Dev. Eff.* 6 (1), 1–43.
- Baird, S., Ferreira, F.H.G., Özler, B., Woolcock, M., 2013. Relative effectiveness of conditional and unconditional cash transfers for schooling outcomes in developing countries: a systematic review. *Campbell Syst. Rev.* 9 (8), 1–124. <https://doi.org/10.4073/csr.2013.8>.
- Bedran-Martins, A.M., Lemos, M.C., 2017. Politics of drought under Bolsa Família program in Northeast Brazil. *World Dev. Perspect.* 7–8, 15–21. <https://doi.org/10.1016/j.wdp.2017.10.003>.
- Bennett, G., Ruef, F., 2016. Alliance for Green Infrastructure State of Watershed Investment 2016. Forest Trends, Washington, DC.
- Bétrisey, F., Mager, C., 2014. Small farmers in Florida Province, Bolivia: reciprocity in practice. *Mt. Res. Dev.* 34 (4), 369–374. <https://doi.org/10.1659/MRD-JOURNAL-D-14-00013.1>.
- Blay, D., Appiah, M., Damnyag, L., 2008. Involving local farmers in rehabilitation of degraded tropical forests: some lessons from Ghana. *Environ. Dev. Sustainability* 10 (4), 503–518.
- Bottazzi, P., Wiik, E., Crespo, D., Jones, J.P.G., 2018. Payment for environmental “self-service”: exploring the links between farmers’ motivation and additionality in a conservation incentive programme in the Bolivian Andes. *Ecol. Econ.* 150, 11–23. <https://doi.org/10.1016/j.ecolecon.2018.03.032>.
- Bremer, L., Auerbach, D.A., Goldstein, J.H., Vogl, A.L., Shemie, D., Kroeger, T., Nelson, J.L., Benítez, S.P., Calvache, A., Guimarães, J., Herron, C., Higgins, J., Klemz, C., León, J., Sebastián Lozano, J., Moreno, P.H., Nuñez, F., Veiga, F., Tiepolo, G., 2016. One size does not fit all: natural infrastructure investments within the Latin American Water Funds Partnership. *Ecosyst. Serv.* 17, 217–236. <https://doi.org/10.1016/j.ecoser.2015.12.006>.
- Bremer, L., Farley, K., Lopez-Carr, D., 2014. What factors influence participation in payment for ecosystem services programs? An evaluation of Ecuador’s SocioPáramo program. *Land Use Policy* 36, 122–133.
- Clarke, M., Ma, Z., Snyder, S., Floress, K., 2019. What are family forest owners thinking and doing about invasive plants? *Landscape Urban Plann.* <https://doi.org/10.1016/j.landurbplan.2018.10.024>.
- Corbera, E., Kosoy, N., Martínez Tuna, M., 2007. Equity implications of marketing ecosystem services in protected areas and rural communities: case studies from Meso-America. *Global Environ. Change* 17 (3–4), 365–380. <https://doi.org/10.1016/j.gloenvcha.2006.12.005>.
- Cranford, M., Mourato, S., 2011. Community conservation and a two-stage approach to payments for ecosystem services. *Ecol. Econ.* 71, 89–98.
- Cunha, J., 2014. Testing Paternalism: Cash versus In-Kind Transfers. *Am. Econ. J.: Appl. Econ.* 6 (2), 195–230.
- Currie, J., Gahvari, F., 2008. Transfers in cash and in-kind: theory meets the data. *J. Econ. Lit.* 46 (2), 333–383.
- Devereux, S., Vincent, K., 2010. Using technology to deliver social protection: exploring opportunities and risks. *Dev. Pract.* 20 (3), 367–379.
- Dillaha, T., Ferraro, P., Huang, M., Southgate, D., Upadhyaya, S., Wunder, S., 2007. Payments for watershed services regional syntheses. USAID PES Brief No. 7. Office of International Research, Education, and Development (OIRE), Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Engel, S., 2016. The devil in the detail: a practical guide on designing payments for environmental services. *Int. Rev. Environ. Resour. Econ.* 9 (1–2), 131–177.
- Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. *Ecol. Econ.* 65 (4), 663–674. <https://doi.org/10.1016/j.ecolecon.2008.03.011>.
- Farley, K., Anderson, W., Bremer, L., Harden, C., 2011. Compensation for ecosystem services: an evaluation of efforts to achieve conservation and development in Ecuadorian páramo grasslands. *Environ. Conserv.* 38, 393–405.
- Farley, J., Costanza, R., 2010. Payments for ecosystem services: from local to global. *Ecol. Econ.* 69 (11), 2060–2068. <https://doi.org/10.1016/j.ecolecon.2010.06.010>.
- Fletcher, R., Breiting, J., 2012. Market mechanism or subsidy in disguise? Governing payment for environmental services in Costa Rica. *Geoforum* 43, 402–411.
- Fuentes-George, K., 2013. Neoliberalism, environmental justice, and the convention on biological diversity: how problematizing the commodification of nature affects regime effectiveness. *Global Environ. Politics* 13 (4), 144–163. https://doi.org/10.1162/GLEP_a_00202.
- Gangopadhyay, S., Lensink, R., Yadav, B., 2015. Cash or in-kind transfers? Evidence from a randomised controlled trial in Delhi, India. *J. Dev. Stud.* 51 (6), 660–673.
- Goldman, R., Benítez, S., Calvache, A., Montambault, J., 2010. *Measuring the Effectiveness of Water Funds: Guidance Document for Development of Impact Measures*. The Nature Conservancy, Arlington, VA. <https://www.conservationgateway.org/Documents/Final%20Water%20Funds%20Impact%20Measures%20Guidance%20Document.pdf>.
- Goldman-Benner, R.L., Benítez, S., Boucher, T., Calvache, A., Daily, G., Kareiva, P., Kroeger, T., Ramos, A., 2012. Water funds and payments for ecosystem services: practice learns from theory and theory can learn from practice. *Oryx* 46 (1), 55–63. <https://doi.org/10.1017/S0030605311001050>.
- Gong, Y., Bull, G., Baylis, K., 2010. Participation in the World’s first clean development mechanisms forest project: the role of property rights, social capital and contractual rules. *Ecol. Econ.* 69, 1292–1302.
- Graham, S., Rogers, S., 2017. How local landholder groups collectively manage weeds in South-Eastern Australia. *Environ. Manage.* 60 (3), 396–408. <https://doi.org/10.1007/s00267-017-0859-7>.
- Grieg-Gran, M., Porras, I., Wunder, S., 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Dev.* 33 (9), 1511–1527. <https://doi.org/10.1016/j.worlddev.2005.05.002>.
- Grillos, T., 2017. Economic vs non-material incentives for participation in an in-kind payments for ecosystem services program in Bolivia. *Ecol. Econ.* 131, 178–190. <https://doi.org/10.1016/j.ecolecon.2016.08.010>.
- Grillos, T., Bottazzi, P., Crespo, D., Asquith, N.M., Jones, J.P.G., 2019. In-kind conservation payments crowd in environmental values and increase support for government intervention: a randomized trial in Bolivia. *Ecol. Econ.* 166, 106404. <https://doi.org/10.1016/j.ecolecon.2019.106404>.
- Hayes, T., 2012. Payment for ecosystem services, sustained behavioral change, and adaptive management: peasant perspectives in the Colombian Andes. *Environ. Conserv.* 39 (2), 144–153.
- Hayes, T., Murtinho, F., Wolff, H., 2017. The impact of payments for environmental services on communal lands: an analysis of the factors driving household land-use behavior in Ecuador. *World Dev.* 93, 427–446.
- Hayes, T., Grillos, T., Bremer, L., Murtinho, F., Shapiro, E., 2019. Collective PES: More than the sum of individual incentives. *Environ. Sci. Policy* 102, 1–8. <https://doi.org/10.1016/j.envsci.2019.09.010>.
- Hegde, R., Bull, G.Q., Wunder, S., Kozak, R.A., 2015. Household participation in a payments for environmental services programme: the Nhamitso Forest Carbon Project (Mozambique). *Environ. Dev. Econ.* 20 (5), 611–629. <https://doi.org/10.1017/S1355770X14000631>.
- Jackson, R.J., Palmer, L., 2015. Reconceptualizing ecosystem services: possibilities for cultivating and valuing the ethics and practices of care. *Prog. Hum. Geogr.* 39 (2), 122–145.
- Jayachandran, S., de Laat, J., Lambin, E.F., Stanton, C.Y., Audy, R., Thomas, N.E., 2017. Cash for carbon: a randomized trial of payments for ecosystem services to reduce deforestation. *Science* 357 (6348), 267.
- Kemkes, R.J., Farley, J., Koliba, C.J., 2010. Determining when payments are an effective policy approach to ecosystem service provision. *Ecol. Econ.* 69 (11), 2069–2074. <https://doi.org/10.1016/j.ecolecon.2009.11.032>.
- Kerr, J.M., Vardhan, M., Jindal, R., 2014. Incentives, conditionality and collective action in payment for environmental services. *Int. J. Commons* 8 (2), 595–616.
- Kolijivadi, V., Grant, A., Adamowski, J., Kosoy, N., 2015. Juggling multiple dimensions in a complex ecosystem: the issue of targeting in payments for ecosystem services. *Geoforum* 58, 1–13.
- Krause, T., Loft, L., 2013. Benefit distribution and equity in Ecuador’s Socio Bosque Program. *Soc. Nat. Resour.* 26 (10), 1170–1184. <https://doi.org/10.1080/08941920.2013.797529>.
- Lansing, D., 2014. Unequal access to payments for ecosystem services: the case of Costa Rica. *Dev. Change* 45 (6), 1310–1331.
- Lansing, D., 2017. Understanding smallholder participation in ecosystem service payments: evidence from Costa Rica. *Hum. Ecol.* 45 (1), 77–87.
- Ma, Z., Bauchet, J., Steele, D., Godoy, R.A., Radel, C., Zanotti, L., 2017. Comparison of direct transfers for human capital development and environmental conservation. *World Dev.* 99, 498–517. <https://doi.org/10.1016/j.worlddev.2017.05.030>.
- Martinez, R., Green, K.M., DeWan, A., 2013. Establishing reciprocal agreements for water and biodiversity conservation through a social marketing campaign in Quanda Watershed, Peru. *Conserv. Evidence* 10, 42–47.
- Martin-Ortega, J., Ojea, E., Roux, C., 2013. Payments for water ecosystem services in Latin America: a literature review and conceptual model. *Ecosyst. Serv.* 6, 122–132. <https://doi.org/10.1016/j.ecoser.2013.09.008>.
- McAfee, K., 2012. The contradictory logic of global ecosystem service markets. *Dev. Change* 43 (1), 105–131.
- McAfee, K., Shapiro, E., 2010. Payments for ecosystem services in Mexico: Nature, neo-liberalism, social movements, and the state. *Ann. Assoc. Am. Geogr.* 100 (3), 579–599.
- McElwee, P., 2012. Payments for environmental services as neoliberal market-based forest conservation in Vietnam: panacea or problem? *Geoforum* 43, 412–426.
- Milder, J.C., Scherr, S.J., Bracer, C., 2010. Trends and future potential of payment for ecosystem services to alleviate rural poverty in developing countries. *Ecol. Soc.* 15 (2).
- Milne, S., Adams, B., 2012. Market masquerades: uncovering the politics of community-level payments for environmental services in Cambodia. *Dev. Change* 43 (1), 133–158.
- Mittermeier, R.A., Turner, W.R., Larsen, F.W., Brooks, T.M., Gascon, C., 2011. Global biodiversity conservation: the critical role of hotspots. In: Zachos, F.E., Habel, J.C. (Eds.), *Biodiversity Hotspots: Distribution and Protection of Conservation Priority Areas*. Springer, Berlin Heidelberg, Berlin, Heidelberg, pp. 3–22.
- Muñoz-Piña, C., Guevara, A., Torres, J.M., Braña, J., 2008. Paying for the hydrological services of Mexico’s forests: analysis, negotiations and results. *Ecol. Econ.* 65 (4), 725–736. <https://doi.org/10.1016/j.ecolecon.2007.07.031>.
- Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. *Ecol. Econ.* 69 (6), 1202–1208. <https://doi.org/10.1016/j.ecolecon.2009.11.006>.
- Nelson, S.H., Bremer, L.L., Meza Prado, K., Brauman, K.A., 2020. The political life of natural infrastructure: water funds and alternative histories of payments for ecosystem services in Valle del Cauca, Colombia. *Dev. Change* 51 (1), 26–50.
- Neumann, R.P., 2005. *Making Political Ecology*. Routledge, New York, NY.

- Norgaard, R.B., 2010. Ecosystem services: from eye-opening metaphor to complexity blinder. *Ecol. Econ.* 69 (6), 1219–1227. <https://doi.org/10.1016/j.ecolecon.2009.11.009>.
- Osborne, T., 2015. Tradeoffs in carbon commodification: a political ecology of common property forest governance. *Geoforum* 67, 64–77. <https://doi.org/10.1016/j.geoforum.2015.10.007>.
- Ostrom, E., 2003. Toward a behavioral theory linking trust, reciprocity, and reputation. In: Ostrom, E., Walker, J. (Eds.), *Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research*. Russell Sage Foundation, New York, NY, pp. 19–79.
- Owens, S., 2000. 'Engaging the Public': information and deliberation in environmental policy. *Environ. Plann. A: Econ. Space* 32 (7), 1141–1148. <https://doi.org/10.1068/a3330>.
- Pagiola, S., Arcenas, A., Platais, G., 2005. Can payments for environmental services help reduce poverty? an exploration of the issues and the evidence to date from Latin America. *World Dev.* 33 (2), 237–253. <https://doi.org/10.1016/j.worlddev.2004.07.011>.
- Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: a conceptual approach. *Ecol. Econ.* 69 (6), 1237–1244. <https://doi.org/10.1016/j.ecolecon.2009.11.004>.
- Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Gomez-Baggethun, E., Muradian, R., 2014. Social equity matters in payments for ecosystem services. *Bioscience* 64 (11), 1027–1036.
- Pattanayak, S., Wunder, S., Ferraro, P.J., 2010. Show me the money: do payments supply environmental services in developing countries? *Rev. Environ. Econ. Policy* 4, 254–274.
- Persson, U.M., Alpizar, F., 2013. Conditional cash transfers and payments for environmental services – a conceptual framework for explaining and judging differences in outcomes. *World Dev.* 43, 124–137. <https://doi.org/10.1016/j.worlddev.2012.10.006>.
- Pirard, R., 2012. Market-based instruments for biodiversity and ecosystem services: a lexicon. *Environ. Sci. Policy* 19–20, 59–68. <https://doi.org/10.1016/j.envsci.2012.02.001>.
- Porras, I., Barton, D.N., Miranda, M., Chacón-Cascante, A., 2013. Learning from 20 years of Payments for Ecosystem Services in Costa Rica. International Institute for Environment and Development, London, UK.
- Pynegar, E.L., Gibbons, J.M., Asquith, N.M., Jones, J.P.G., 2019. What role should randomized control trials play in providing the evidence base for conservation? *Oryx*. <https://doi.org/10.1017/S0030605319000188>.
- Pynegar, E.L., Jones, J.P.G., Gibbons, J.M., Asquith, N.M., 2018. The effectiveness of Payments for Ecosystem Services at delivering improvements in water quality: lessons for experiments at the landscape scale. *PeerJ* 6, e5753. <https://doi.org/10.7717/peerj.5753>.
- Robbins, P., 2012. *Political Ecology: A Critical Introduction*, second ed. Wiley-Blackwell, Malden, MA.
- Robertson, L., Mushati, P., Eaton, J.W., Dumba, L., Mavise, G., Makoni, J., Schumacher, C., Crea, T., Monasch, R., Sherr, L., Garnett, G.P., Nyamukapa, C., Gregson, S., 2013. Effects of unconditional and conditional cash transfers on child health and development in Zimbabwe: a cluster-randomised trial. *The Lancet* 381 (9874), 1283–1292. [https://doi.org/10.1016/S0140-6736\(12\)62168-0](https://doi.org/10.1016/S0140-6736(12)62168-0).
- Robertson, N., Wunder, S., 2005. In: *Fresh Tracks In the Forest: Assessing Incipient Payments for Environmental Services Initiatives in Bolivia*. Center for International Forestry Research (CIFOR), Bogor, Indonesia, pp. 1–150.
- Rodríguez de Francisco, J.C., Budds, J., Boelens, R., 2014. Payment for Environmental Services and unequal resource control in Pimampiro, Ecuador. *Soc. Nat. Resour.* 26, 1217–1233.
- Rodríguez, L., Pascual, U., Muradian, R., Pazmino, N., Whitten, S., 2011. Towards a unified scheme for environmental and social protection: learning from PES and CCT experiences in developing countries. *Ecol. Econ.* 70, 2163–2174.
- Rouleau, M.D., Lind-Riehl, J.F., Smith, M.N., Mayer, A.L., 2016. Failure to communicate: inefficiencies in voluntary incentive programs for private forest owners in Michigan. *Forests* 7 (9), 199.
- Salzman, J., Bennett, G., Carroll, N., Goldstein, A., Jenkins, M., 2018. The global status and trends of Payments for Ecosystem Services. *Nat. Sustainability* 1 (3), 136–144. <https://doi.org/10.1038/s41893-018-0033-0>.
- Samii, C., Lisiecki, M., Kulkarni, P., Paler, L., Chavis, L., 2014. Effects of Payment for Environmental Services (PES) on deforestation and poverty in low and middle income countries: a systematic review. *Campbell Syst. Rev.*
- Santos de Lima, L., Barón, P.A.R., Villamayor-Tomas, S., Krueger, T., 2019. Will PES schemes survive in the long-term without evidence of their effectiveness? Exploring four water-related cases in Colombia. *Ecol. Econ.* 156, 211–223. <https://doi.org/10.1016/j.ecolecon.2018.09.005>.
- Santos de Lima, L., Krueger, T., García-Marquez, J., 2017. Uncertainties in demonstrating environmental benefits of payments for ecosystem services. *Ecosyst. Serv.* 27, 139–149. <https://doi.org/10.1016/j.ecoser.2017.09.005>.
- Schomers, S., Matzdorf, B., 2013. Payments for Ecosystem Services: a review and comparison of developing and industrialized countries. *Ecosyst. Serv.* 6, 16–30.
- Shapiro-Garza, E., 2013a. Contesting market-based conservation: payments for ecosystem services as a surface of engagement for rural social movements in Mexico. *Human Geography* 6 (1), 134–150.
- Shapiro-Garza, E., 2013b. Contesting the market-based nature of Mexico's national payments for ecosystem services programs: four sites of articulation and hybridization. *Geoforum* 46, 5–15. <https://doi.org/10.1016/j.geoforum.2012.11.018>.
- Shapiro-Garza, E., McElwee, P., Van Hecken, G., Corbera, E., 2020. Beyond Market logics: payments for ecosystem services as alternative development practices in the Global South. *Dev. Change* 51 (1), 3–25. <https://doi.org/10.1111/dech.12546>.
- Sommerville, M., Jones, J., Rahajaharison, M., Milner-Guilland, E.J., 2010. The role of fairness and benefit distribution in community-based payment for environmental services interventions: a case study from Menabe, Madagascar. *Ecol. Econ.* 69, 1262–1271.
- Sommerville, M., Jones, J.P.G., Milner-Guilland, E.J., 2009. A revised conceptual framework for payments for environmental services. *Ecol. Soc.* 14 (2).
- Stanton, T., Echavarria, M., Hamilton, K., Ott, C., 2010. State of Watershed Payments: An Emerging Marketplace. Ecosystem Marketplace. Forest Trends, Washington, DC.
- Swallow, B.M., Kallesoe, M.F., Iftikhar, U.A., van Noordwijk, M., Bracer, C., Scherr, S.J., Raju, K.V., Poats, S.V., Duraiappah, A.K., Ochieng, B.O., Mallee, H., Rumley, R., 2009. Compensation and rewards for environmental services in the developing world: framing pan-tropical analysis and comparison. *Ecol. Soc.* 14 (2).
- Tacconi, L., 2012. Redefining payments for environmental services. *Ecol. Econ.* 73, 29–36.
- Tallis, H., Kareiva, P., Marvier, M., Chang, A., 2008. An Ecosystem services framework to support both practical conservation and economic development. *PNAS* 105 (28), 9457–9464.
- Tinbergen, J., 1952. *On the Theory of Economic Policy*. North-Holland, Amsterdam.
- Van Hecken, G., Bastiaensen, J., 2010. Payments for ecosystem services: Justified or not? A political view. *Environ. Sci. Policy* 13 (8), 785–792. <https://doi.org/10.1016/j.envsci.2010.09.006>.
- van Noordwijk, M., Leimona, B., 2010. Principles for fairness and efficiency in enhancing environmental services in Asia: payments, compensation, or co-investment? *Ecol. Soc.* 15 (4), 17.
- Vargas, M.T., Forno, M., Secomb, S., Torrico, J., 2010. Compensation for hydrological services in Bolivia: the Comarapa Municipal Water Fund. *Mount. Forum Bull.* X (1), 76–78.
- Vatn, A., 2010. An institutional analysis of payments for environmental services. *Ecol. Econ.* 69 (6), 1245–1252. <https://doi.org/10.1016/j.ecolecon.2009.11.018>.
- von Hedemann, N., Osborne, T., 2016. State forestry incentives and community stewardship: a political ecology of payments and compensation for ecosystem services in Guatemala's Highlands. *J. Latin Am. Geogr.* 15 (1), 83–110. <https://doi.org/10.1353/lag.2016.0002>.
- Wiik, E., d'Annunzio, R., Pynegar, E., Crespo, D., Asquith, N.M., Jones, J.P.G., 2019. Experimental evaluation of the impact of a payment for environmental services program on deforestation. *Conserv. Sci. Pract.* 1 (2), e8. <https://doi.org/10.1002/csp.28>.
- Wiik, E., Jones, J.P.G., Pynegar, E., Bottazzi, P., Asquith, N.M., Gibbons, J., Kontoleon, A., 2020. Mechanisms and impacts of an incentive-based conservation program with evidence from a randomized control trial. *Conserv. Biol.* <https://doi.org/10.1111/cobi.13508>.
- Wunder, S., 2005. Payments for Environmental Services: Some Nuts and Bolts. Center for International Forestry Research (CIFOR), Bogor, Indonesia, pp. 1–24.
- Wunder, S., 2008. Payments for environmental services and the poor: concepts and preliminary evidence. *Environ. Dev. Econ.* 13 (3), 279–297. <https://doi.org/10.1017/S1355770X08004282>.
- Wunder, S., 2013. When payments for environmental services will work for conservation. *Conserv. Lett.* 6 (4), 230–237. <https://doi.org/10.1111/cons.12034>.
- Wunder, S., 2015. Revisiting the Concept of Payments for Environmental Services. *Ecol. Econ.* 117, 234–243.
- Wunder, S., Brouwer, R., Engel, S., Ezzine-de-Blas, D., Muradian, R., Pascual, U., Pinto, R., 2018. From principles to practice in paying for nature's services. *Nat. Sustainability* 1 (3), 145–150. <https://doi.org/10.1038/s41893-018-0036-x>.
- Wunder, S., Engel, S., Pagiola, S., 2008. Taking stock: a comparative analysis of payments for environmental services programs in developed and developing countries. *Ecol. Econ.* 65 (4), 834–852. <https://doi.org/10.1016/j.ecolecon.2008.03.010>.
- Wunder, S., The, B.D., Ibarra, E., 2005. Payment is Good, Control is Better: Why Payments for Forest Environmental Services in Vietnam have so far Remained Incipient. Center for International Forestry Research (CIFOR), Bogor, Indonesia, pp. 1–61.
- Zbinden, S., Lee, D.R., 2005. Paying for environmental services: an analysis of participation in Costa Rica's PSA program. *World Dev.* 33 (2), 255–272. <https://doi.org/10.1016/j.worlddev.2004.07.012>.