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Influence of local context variables on the outcomes of payments for ecosystem services. Evidence from San Antonio del Barrio, Oaxaca, Mexico

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Abstract

Payment for ecosystem services (PES) is the main economic instrument developed for natural resource conservation. Evidence has shown the importance of local context in PES design and implementation and the complexity of defining and specifying that context. Using the socio-ecological systems framework, through surveys and interviews conducted in San Antonio, an indigenous community in Mexico with a forest socio-ecological system, this paper analyzes 13 variables as a way to approximate local context. The results show that the main contextual variables are forest cover, opportunity costs, livelihood, income, motivations and attitudes toward conservation, confidence and cooperation, traditional management practices, internal organization, land tenure, rules for the management and use of natural resources, presence and history of non-governmental organizations, economic and conservation history and distance to markets. In addition, the analysis of local context and PES outcomes in San Antonio leads us to conclude that a close relationship exists between the local context variables and the variables defined as causes of the PES outcomes.

Keywords Payments for environmental services · Local context · Socio-ecological systems · Economic instruments for natural resource conservation · Livelihoods

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1 Introduction

Payment for ecosystem services (PES) is an economic instrument used in several countries as part of environmental public policies (Mayran and Paquin 2004; Fisher et al. 2009; Balvanera et al. 2012; McElwee 2012; Molnar and Kubiszewski 2012). The purpose of PES is to compensate people who conserve ecosystems, ensuring the permanence and quality of ecosystems and improving human well-being (Fregoso 2006; DDS-OEA 2008). This scheme aims to improve the state of ecosystems, and compensation allows for the internalization of externalities (Martínez-Alier and Roca 2001; McElwee 2012).

PES outcomes have shown that opportunity costs are high, and economic benefits for households in terms of income are limited. The environmental effects, measured mainly in terms of forest cover, are generally positive, but low additionality has also been mentioned, and sometimes, leakage effects are observed (Alix-Garcia et al. 2015).

PES program outcomes are also related to changes in behavior and, more precisely, in more sustainable production practices and environmental awareness (Rico et al. 2011; Perevochtchikova and Rojo 2015; Rodríguez-Robayo et al. 2016). In summary, appropriation of the program and the environmental, economic and social aspects are the main topics when measuring PES outcomes.

In addition, outcomes vary depending on the context, which according to Panelli (2002) includes cultural, social, economic, political and spatial elements; because context is the processes that shape people's surroundings that constrain and/or enable life, including circumstances, structures and processes that create a dynamic.

There is evidence of the need for PES design and implementation to be rooted in a deep understanding of the local context of the community beneficiaries; nevertheless, there is no greater clarity on how local context conceptualization could be addressed (Frost and Bond 2008; Cranford and Mourato 2011; Lapeyre et al. 2015; Van Hecken et al. 2015; Rodríguez-Robayo et al. 2016).

Context is thus considered a relevant element in the design, implementation and evaluation of public policies (Merino and Martínez 2014). Its analysis allows us to understand the problems faced by actors and to identify opportunities and alternative solutions (Licha 2000; López et al. 2014).

Conversely, the design and implementation of PES schemes are related to regions with natural richness in terms of biodiversity, forest cover and water resources (among others), and in Mexico, these characteristics are mostly present in territories with collective land tenure. Therefore, the ecological systems are intrinsically connected with social systems.

There are different frameworks for analyzing social ecological systems. Binder et al. (2013) compared ten frameworks (driver, pressure, state, impact, response; earth system analysis; ecosystem services; human–environment systems framework; material and energy flow analysis; management and transition framework; social ecological system framework; sustainable livelihood approach; the natural step; and the vulnerability framework), which allowed them to analyze the context with in an integrative manner that considers the inter-action between social and ecological systems.

The authors found that socio-ecological system (SES) framework offers a generic dataorganizing structure. It is the most general framework, and data collected within its structure could potentially be used in any of the other frameworks analyzed. SES provides a framework for selecting the variables necessary to describe the dynamics of both systems. These results suggest the utility of the SES framework in public policy analysis and in PES analysis. In the SES framework, ecological systems are closely linked to one or more social systems (Anderies et al. 2004). The interaction between social and biophysical agents is identified using this framework (Janssen and Ostrom 2006).

According to McGinnis and Ostrom (2014), SES is described in terms of five categories (or first-level variables) related to the resource system, the resource units, governance, actors and exogenous conditions. In each group, second- and third-level variables are identified, and these variables define the local context variables.

In addition, the authors defined the presence of "stressors," which could include the implementation of PES schemes that modify the interactions between community members and their natural resources through PES "outcomes," which can be divided into environmental, social and economic outputs.

To unify the diverse context approximations in PES analysis, Rodríguez-Robayo and Merino-Pérez (2017) identified the "context variables" as the characteristics describing the local conditions in which PES is implemented. They distributed them into the first-level variables of the Ostrom framework of SES. The authors proposed identifying the "focal variables" as the most usual local context characteristics analyzed in PES, based on: (1) a PES literature review of 46 scientific articles that contained in their discussion and conclusion sections the following words: context, conditions, local factors or local characteristics and payment for environmental or ecosystem services and (2) 30 online surveys of non-governmental organizations (NGOs) with certified experience in the implementation of PES programs in Mexico and of National Forestry Commission (CONAFOR) employees directly engaged in the implementation of the program.

The focal variables defined by the authors are: (1) forest cover; (2) opportunity cost; (3) livelihood and productive diversification; (4) motivation and attitudes toward conservation; (5) confidence and cooperation; (6) traditional management practices; (7) internal organization; (8) land tenure; and (9) rules for the management and use of natural resources.

The proposal of focal context variables described by Rodríguez-Robayo and Merino-Pérez (2017) has not been tested empirically, and the relationship between context variables and PES outcomes (local actors' perceptions of environmental, economic and social topics) has not been explored. These goals constitute the next step in defining specific conditions for PES implementation, and they are the objectives of this paper. We suggest that the validation of the context variables and their relationships with the outcomes of PES as "outputs" of the forestry SES contribute to the evaluation process (and possible subsequent reformulation) of the environmental public policy instruments.

2 Methods

2.1 PES schemes in Mexico

The National Forestry Commission (CONAFOR) in 2003 began the implementation of PES schemes in Mexico, following the experience of Costa Rica (since 1996) and international agreements (Rodríguez-Robayo and Avila-Foucat 2013). PES began as a federal program for hydrological service conservation that was aimed at the conservation of forest areas located in priority regions to guarantee water recharge. The program also aims to combat the complex problem of deforestation and poverty in these territories (Perevocht-chikova and Ochoa 2012).

The PES program has been functioning for more than one decade, with 8494 participants, 5 million hectares incorporated and 806 million dollars (data until 2015) (Perevochtchikova 2016).

Since 2008, the Mexican government has developed matching funds, another type of PES scheme, which are local mechanisms by which different organizations and direct users participate in the implementation of the compensation program. The government through CONAFOR provides 50% of the compensation, and the other 50% is provided ideally by consumers of the ecosystem service (local governments). Non-governmental organizations can be involved as well, and in most cases, an atmosphere of trust is created (Saldaña-Herrera 2013). Each forest area has only one PES scheme (federal PES programs or matching funds), and the government intention is that forest areas with federal PES schemes move toward matching funds.

2.2 Study area: San Antonio as a forestal SES

2.2.1 Territorial location

Oaxaca is the Mexican state with PES schemes with the largest area (SEMARNAT 2012), and at the same time, it has high biological and cultural richness (García-Mendoza et al. 2004).

In the "Sierra Norte" (northern highlands), there is one of the most important biological corridors in Mexico, which has been preserved thanks to powerful social organization and the favorable attitudes of the communities toward new conservation initiatives (Galindo 2010).

Among the best examples of communities in Mexico that have been able to promote voluntary conservation schemes is Corenchi (Regional Committee of Natural Resources of Chinantla Alta), which consists of six communities: Santa Cruz Tepetotutla; San Antonio del Barrio; San Pedro Tlatepusco; Santiago Tlatepusco; Nopalera del Rosario; and San Antonio Analco (Anta 2010).

Over time, some communities have joined and left the PES initiative. However, the pioneer of this change on a local scale, the communities of Santa Cruz Tepetotutla and San Antonio have maintained their work and interest.

This study was performed in one of the communities of the Corenchi group: San Antonio del Barrio (hereinafter San Antonio), located in the municipality of San Felipe Usila, 6 h by car to the north of the state capital (Fig. 1).

2.2.2 System and units of resources

San Antonio is located in a mountainous zone (2400–3200 meters above sea level, m.a.s.l.) in one of the most important biological corridors in Mexico. The forest cover consists of perennial tropical forests, cloud forests and pine–oak forests. More than half of this territory has been declared protected area by community agreement. The relevance of its forests is related to the ability to intercept and condense fog and to ensure the availability of water superficially and at the phreatic level.



Fig.1 Communities of the CORENCHI group and San Antonio del Barrio. By Arturo Ramos based on information of RAN (2017) and CONAFOR (2016)

2.2.3 Actors

San Antonio is an agrarian community with an area of 2566.8 ha. According to Molina-González (2011), San Antonio is a Chinantecan indigenous community (approximately from 1300 to 1400 BC). It is considered pre-Hispanic, with defined social and natural characteristics in its territories and low population density. It is located in a region of difficult access, isolating it geographically from other communities.

San Antonio is composed of 46 families, and the total population is approximately 200 people. The family economy is based on a multi-cultivation system for subsistence, mainly maize, beans and cassava, accompanied by shade coffee for commercial exchange (Field-work 2016).

2.2.4 Governance

The community land tenure is communal land under the control of 95 comuneros (landowners with titles of property), with a traditional system of governance called "usos y costumbres," in which the general assembly is the highest political-administrative authority and in which "tequios" (work without remuneration) and the system of "cargos" (social choice positions with responsibility to the community) define the identity of the community.

San Antonio has been part of Corenchi (Regional Committee of Natural Resources of Chinantla Alta) since its foundation in 2004, and with the support of the NGO GeoConservación, it has undertaken various types of actions to improve the management of its forest resources, strengthen conservation efforts and obtain socioeconomic benefits (focused on participation in PES schemes).

Recently, communities have attracted researchers on the subject of biological and cultural diversity and community forest management. In particular, close links have been

Table 1 PES schemes in San Antonio del Barrio. Source:	PES schemes	Year	Area (ha)	Amount of money (US\$)
Offered by CONAFOR (Field	Federal PES program	2004	1200.00	203,180.21
work, August 2010)		2007	400.00	78,654.16
		2009	1072.18	206,291.09
	Matching funds	2011	308.93	188,618.19
		2012	305.07	206,903.07
		2013	350.00	207,782.10
		2014	499.94	284,115.14
		2016	465.00	147,656.50
	Total		4601.12	1523,200.46

established with the Oaxaca Unit of the National Polytechnic Institute (CIIDIR-IPN), and they have also supported the presence of GeoConservación. When it was proposed to perform the present study, the proposal was channeled through these two institutions to the Corenchi. In response, it was decided to perform the study in the community of San Antonio, as a community with characteristics similar to and representative of the region, it has always participated in Corenchi, even fulfilling the directive role on several occasions.

2.2.5 PES schemes as stressors in San Antonio's forestal SES

The federal PES program was implemented in San Antonio in 2004, 2007 and 2009, with the three periods collectively adding approximately 2600 ha (Table 1). The non-governmental organization (NGO) GeoConservación promoted in San Antonio the establishment of a community statute (law of the people, local rules for internal organization), the National Agrarian Register (documentary backing of collective ownership) and territorial planning (defining the areas destined for productive activities, extraction of timber resources, construction of houses and conservation). All of these documents were developed in 2001–2004, and they are necessary to be able to participate in the federal PES program.

The matching fund started in the community in 2011 and is composed by CONAFOR, a regional coffee organization called CEPCO (based on its acronym in Spanish) and Geo-Conservación. The matching fund has contributed for 5 years to the protection of approximately 2000 ha of forest (Table 1).

2.3 Method for analyzing the local context and the perception of PES schemes outcomes

Following the SES framework described in the Introduction section, we propose analyzing the San Antonio experience as a forest socio-ecological system. According to McGinnis and Ostrom (2014), SES is described in terms of five categories (or first-level variables) related to natural resources (system and units of resources), governance and actors. The context variables are the second- and third-level variables of these categories.

Thus, PES schemes are incorporated as a stressor, and the outcomes of PES are a group of SES outputs organized into environmental, social and economic topics (Fig. 2).

We define four methodological parts as follows: (a) approach to focal variables to characterize the local context; (b) selection of PES outcome variables; (c) relationship



Fig. 2 Forestal SES of San Antonio

between the two aforementioned groups of variables; and (d) data collection. The methodological parts a and c follow the variables organization proposed by McGinnis and Ostrom (2014).

2.3.1 The nine focal variables of the local context

This paper adopts the nine focal variables suggested by Rodríguez-Robayo and Merino-Pérez (2017) to characterize the local context in the analysis of PES schemes: (1) forest cover; (2) opportunity costs; (3) livelihood and productive diversification; (4) motivation and attitudes toward conservation; (5) confidence and cooperation; (6) traditional management practices; (7) internal organization; (8) land tenure; and (9) rules for the management and use of natural resources. Table 2 summarizes our interpretation of each focal variable and the points selected to address each variable.

This group of variables was defined by the authors cited, following the variable categorization proposed by McGinnis and Ostrom (2014) through two phases: First, they reviewed 46 indexed PES papers emphasizing the relevance of context in PES design and implementation, and second, they validated the variables through surveys of NGOs with certified experience in the implementation of PES programs in Mexico and of CONAFOR employees directly engaged with implementation of the program. Therefore, this exercise is the first to prove this group of variables in the fieldwork.

2.3.2 The perception of PES outcomes

We define a group of variables to analyze PES scheme outcomes in terms of the perception of SES providers around environmental (contributions to forest protection), social (incidence in confidence, cooperation, organization) and economic (family and community incomes) PES outcomes. Table 3 describes the interpretation of each PES outcome variable.

Focal variables of local context	Description
Natural resources (resource system and resource uni	its)
(1) Forest cover	Perception of natural resource availability in the community Perception of forest conservation state
(2) Opportunity cost	Forest use if PES schemes do not exist Sources of family income if PES schemes do not exist
Actors	
(3) Livelihood	Changes in economic activities throughout the his- tory of the community Main productive activities of families Average monthly income
(4) Pro-conservation attitudes	History of conservation projects in the community Direct and indirect use values and nonuse values associated with the forest
(5) Confidence and cooperation	Importance of a collective work practice called "tequio" and participation in the system of posi- tions (cargos) Confidence of the community toward external actors
(6) Traditional management practices	Changes in the relationship and use of natural resources Motivations to frequent the community forest; ben- efits from the forest
Governance	
(7) Internal organization	Description of periodicity, attendance and account- ability in assemblies Description of the system of positions (cargos) and number of persons in the system
(8) Land tenure	History of land tenure in the community; number of land owners in the community Area of worked land (coffee, subsistence crops, pasture) per family
(9) Rules for the management and use of natural resources	Description of the development of community statute and land use planning Most important rules and agreements in the manage- ment and use of natural resources Interest in changing the community statute

Table 2 Approach to focal variables of the local context

2.3.3 Relationship between local context variables and PES schemes outcomes

The relationship of causality between the local context and the perceived outcomes of the PES schemes was evaluated using the variable called "causes," expanding on the causes of the perceived effects and the motivations of the community to participate for more than 10 years in the implementation of PES schemes.

The survey format included the open-ended question "What do you think are the main reasons that explain the effects of the program in the community?" In addition, the survey included another question with multiple choices: "Do you agree the frequent participation in PES and its outcomes are due to (multiple options)." The answers to the questions were organized according to the variable classification proposed by McGinnis

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PES outcome variables	Description
Appropriation	General perception of the PES program Knowledge about PES objectives, activities and benefits distribution
Environmental outcomes	Overall program outcomes in environmental terms (conservation) Perceptions of program contributions to forest protection
Economic outcomes	Overall program outcomes in economic terms (income strengthening) Perception of program contributions to family income, community income Contributions to the promotion of new productive activities
Social outcomes	Overall program outcomes in social terms (strengthening of public and common goods, confidence, cooperation) Problems generated by the program in the community Contributions to the organizational capacity and to the trust among com- munity members

 Table 3
 Approach to PES outcomes

Table 4	Relationship	context-	-PES	outcomes
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Relationship variable	Description
Causes	Perception of determinant causes of the PES outcomes The frequent participation in PES and its outcomes may be because: Families need additional income There is a lot of confidence and cooperation among community members The internal organization is strong The community has defined strict agreements and rules regarding the use of natural resources
	There are delimited collective conservation areas The forests have always been protected

and Ostrom (2014): natural resources, actors and governance. Table 4 describes the points selected to evaluate this variable.

2.3.4 Data collection

We inquired, through surveys and interviews (Babbie 1998; Díaz et al. 2011; Chan et al. 2012; Martín-López et al. 2012; Ritchie and Lewis 2003), about the opinions and perception of actors (Corbera et al. 2009; Rico et al. 2011; Rodríguez-Robayo et al. 2016) regarding the outcomes of PES schemes (the earlier federal PES program and the current matching funds program) in San Antonio.

The interview structure consisted of four sections. The first "general data" section addressed general interviewee information, such as name, age, place of birth, main occupation, and current and previous "cargos" (positions in the community). The second section, "on history and community organization," explored historical and organizational aspects of the community, such as the founding of the community, changes in the community's relationship with its natural resources, problems, establishment of rules, monitoring and sanctions. The third section, on "productive activities and sources of income," addressed the main economic activities, government programs and migration processes. The fourth section, on "conservation of natural resources," inquired about forest management, conservation programs and specifically the federal PES program and matching funds program.

A total of 13 interviews (Table 1) were conducted with internal and external actors from the community. The internal actors interviewed (8) were locally recognized actors as key decision makers in conservation issues (such as the municipal agent, President of the Ecotourism Committee, member of the supervisory board and President of Bienes Comunales) and in the promotion of sustainable productive activities (2 representatives of coffee growers, 1 of beekeepers, 1 community representative from Corenchi and 1 community technician). The external actors (5) included people from academia (1, IPN-CIDIR-Oaxaca), local non-governmental organizations (2, GeoConservación and CCMSS) and government (2, from CONAFOR-Oaxaca) who had closely followed the conservation experience of San Antonio. It is important to mention that all of the interviewees from the community had different cargos for "uses and customs," and they participated simultaneously in committees related to the PES program since it was implemented. For this reason, they had good knowledge of the program.

All of the interviews were recorded and later transcribed for systematization and analysis.

The second tool was surveys of family beneficiaries of PES schemes. The survey format had 70 questions distributed in six sections. The first section inquired about "general aspects of the family" associated with family size, ages, schooling, cargos, health insurance and migration. The second section on "natural resources" focused on knowledge of the forests, family uses of the forest and their perceived benefits. The third section on "actors" addressed the land tenure, the land area worked, the average monthly income stated and the average annual income estimated according to the productive activities of the chiefs (agricultural, livestock, forestry, salaried, manufacturing and services). Additionally, it inquired about the amounts and periodicity of subsidies received. The fourth section on "governance" asked about the assemblies and the participation, establishment, and fulfillment of agreements and participation in community organizations. The fifth section on "PES schemes" inquired about knowledge of the programs, their participation, expenditures on financial resources received at the family level, outcomes of the program and causes of the outcomes obtained. The sixth section on "physical capital" asked about the assets that the family owns and the materials of construction of the houses.

A total of 43 surveys were conducted, surveying 93.5% of the families in the community.

The interviews and surveys were conducted during the months of August and October 2016. The approach to the community was made possible by the support of academics from the CIIDIR-IPN-Oaxaca (Interdisciplinary Research Center for Regional Integral Development—National Polytechnic Institute) and GeoConservación.

We created a matrix of responses and a database with the information collected by the interviews and surveys. These tools allowed for the qualitative and quantitative exploration of the following three topics: (a) description of the nine focal variables of the local context; (b) local perceptions of PES outcomes; and (c) relationships between the focal variables of the local context and the perceived PES outcomes.

3 Results

The results summarize the information collected regarding the three topics described above.

3.1 The local context variables in San Antonio

3.1.1 Natural resources

(1) *Forest cover* We found evidence that San Antonio has for many years protected its forests. The respondents perceive the richness of their natural resources, they are proud of contributing to the conservation of endangered species (especially the jaguar), and there is a general perception that the level of forest conservation is very good.

(2) *Opportunity costs* A total of 85% of those surveyed felt that if PES schemes were not implemented in the community, the forests would continue to be conserved as traditionally they have been. The remaining 15% said that the use of land would change to agricultural activities.

In contrast, local actors stated their perception of high opportunity costs because there was an increase in the time invested to comply with the obligations from CONAFOR. PES schemes and territorial planning have also impacted their livelihoods, especially via restrictions on hunting and the cultivation of those food plants that require higher elevations.

The external actors stated that, even without economic instruments such as PES, the forests of San Antonio would be conserved, and its state of conservation would be different from the present one.

3.1.2 Actors

(3) *Livelihoods* The average number of economic activities conducted by the families of San Antonio is four; the most frequent activities are the cultivation of maize, beans and fruit trees (98%); raising of chickens and pigs (86%); informal jobs, such as day laboring and bricklaying (59%); and coffee farming (53%).

The main source of income stated continues to be coffee farming (51%), 28% stated governmental subsidies and the remaining 21% other main sources of income.

The main economic activity 12 years ago (before the arrival of PES) was coffee farming (74%), but since 2014, coffee production has been affected by rust, which has had a significant impact on family income. Currently, it is complemented by apiculture, fish farming, tepejilote (palm fruit) cultivation, ecotourism and textile work (from the embroidery of napkins to the elaboration of detailed huipiles¹).

Income was estimated from the calculation of agricultural, livestock, forestry, manufacturing, informal wages and government incentives (PROSPERA,² PROCAMPO,³ Adultos mayores,⁴ among others). This analysis showed an average monthly income of US\$ 88.6 (2016 dollars), of which 71% is provided by government subsidies.

External actors noted that San Antonio has tried unsuccessfully other livelihoods, such as hunting, barbasco, vanilla and cocoa farming, livestock and logging.

(4) *Motivations and attitudes toward conservation* All of the people surveyed considered forest protection to be important, and its relevance was explained according to the values of direct use, such as provision of water, plants and animals for food (44%), as well

¹ Hand-embroidered traditional blouses.

 $^{^2}$ Social inclusion program of the Secretariat of Social Development.

³ Direct support to producers from the field program of the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food.

⁴ Pension for seniors' program of the Secretariat of Social Development.

as indirect use values associated with water regulation (47%) and nonuse values as legacies for future generations (28%).

The community has promoted norms and rules in favor of conservation, such as species monitoring and prohibition of hunting, use of insecticides in crops and use of detergents in the main water sources, among others.

The external actors emphasized a large sequence of conservation projects, starting in the early 2000s and promoted by CONAFOR, including the National Commission of Protected Natural Areas (CONANP in Spanish) and the National Commission on Biodiversity (CONABIO in Spanish).

(5) *Confidence and cooperation* A total of 100% of the local actors practice voluntary work (tequio), and 84% of the families had at least one head of family who served the community as part of the system of positions (cargos). Additionally, comuneros participate by *tequio* in the execution of activities related to PES programs (e.g., clearance, roads maintenance, activities against fires).

The fulfillment of cargos and tequios is a sign of confidence and cooperation in local institutions (government, organizations, committees, etc.), and it is encouraged by the legitimacy of community institutions and the existence of economic and social sanctions in cases of non-compliance.

Community members trust their authorities because they are chosen by themselves, and the authorities are accountable to the community within the general assembly.

In addition, we also observed evidence of confidence in external agents, such as Geo-Conservación, supported by the perception that the NGO has helped the people to participate in diverse projects and programs.

External actors confirmed all of the above and emphasized the trust among CONA-FOR—San Antonio, CONAFOR—Corenchi, and CONAFOR—GeoConservación.

(6) *Traditional management practices* The surveys showed that families have, on average, two or three motivations to go to the community forest; the main motivations are to harvest food plants, such as wild grapes and coriander (64%); to collect raw material, such as liana, a plant used to make baskets (61%); and to gather wood and firewood (52%).

The main agreements and restrictions regarding the use of natural resources are established at the community statute and territorial planning levels, and all of the community members know and fulfill the management practices specified therein.

Similarly, the external actors emphasize the importance of these two regulatory tools, and they note the support that San Antonio receives from GeoConservación for its development.

3.1.3 Governance

(7) *Internal organization* Eighty-four percent of the families surveyed have at least one head of family with cargo (community position), and 30% of the families have two heads with cargo. In addition, the surveys showed a high annual number of assemblies as many as 32 (an average of 2.5 per month).

The complex system of positions (cargos) demands the attention of all citizens with recognized rights. The types of positions are communal or agrarian goods (12 people), municipal agency or administrative aspects (20 people), religious or church activities (12 people) and external positions (4 people). Usually, one head of family will have two or three positions simultaneously, with high family and economic costs.

External actors emphasize the importance of the assembly as a space for decision making in San Antonio, along with the establishment of strong sanctions when someone breaches agreements.

(8) Land tenure is collective, but each family has an average of 4.8 ha on which it conducts its traditional economic activities, mainly farming of coffee and subsistence crops.

The history of land tenure in San Antonio has been marked by the defense of its territorial limits, ending the disputes at the beginning of 2000. Currently, San Antonio has legal ownership of its land.

The external actors note that San Antonio is a small community with a strong social cohesion closely related to its land. The first settlers were residents of the surrounding areas, which were established in pre-Hispanic times. Throughout history, the people have defended their autonomy and the territory from their neighbors of Santa Cruz and San Antonio Analco.

(9) *Rules for the management and use of natural resources* Sixty-seven percent of families know the community statute, and 72% can name some conservation agreements; 28% feel that they have been affected by the agreements, and 7% want to change the agreements (restrictions on hunting, limits on growing areas, fines for felling trees, etc.).

The community statute and land use planning were established in 2004 and were promoted by GeoConservación for participation in PES programs. Some internal interviewers consider the rules to be very strict because they have substantially reduced the usage of natural resources. Additionally, they consider the sanctions to be extremely harsh (the absence of the owner for more than 2 years can cause loss of his or her rights; absent owners must pay a fine of US\$ 160 (2016\$) for not providing services (cargo) to the community; the owner who does not participate in "tequio" practices must pay someone who replaces him or her—US\$ 6.4/day (2016\$); nonattendance at assemblies incurs a fine of US\$ 3.2.

Once again, external actors emphasize the importance of community statutes and strict compliance with conservation agreements, mainly restrictions on hunting and logging.

3.2 Perception of PES schemes outcomes

Environmental outcomes The environmental outcomes are divided into two components. The first is the appropriation of PES. Only one family surveyed stated that it was not a beneficiary of the current PES scheme (matching funds program). A total of 67% of beneficiaries know the program, and they link the program to conservation activities, support and CONAFOR. External stakeholders note that San Antonio has appropriate PES programs because the community knows, understands and is in agreement with PES schemes, and the conservation of environmental services is linked to the perception of voluntary conservation.

The second is related to conservation perceptions. A total of 72% of respondents recognize the contributions of these programs to the conservation of community forests. They believe that the conservation actions conducted in San Antonio generate local, regional, national and international environmental benefits. Local actors also mention that the level of conservation of their forests is due to the actions that San Antonio conducted prior to the arrival of the PES programs, and they mention that PES schemes have increased the awareness of the benefits conferred by the conservation of natural resources.

The external actors note that federal PES program and matching funds program have helped to conserve areas of high fragility, have reduced forest fires in the state and have promoted changes in management practices, such as better control of fire and monitoring and reduction in hunting.

Economic outcomes In the community, only men give tequio, so when the benefits obtained by participating in the program are distributed, men receive approximately US\$ 184.2 (2016\$) and women receive approximately US\$ 79 (2016\$) per year.

The respondents mostly agree that PES schemes create the largest contributions to family income (93%) and community income (88%). At the same time, only 28% mentioned PES program contributions in the promotion of productive activities, such as honey, fish and shade coffee.

They recognize that PES income has reduced the need for family expenses to fund community projects (road improvements, fuel for community vehicles, etc.), as well as the need to cover the operating costs of local authorities. PES implementation has provided economic income to all community members, and income generated at the family level has been able to mitigate the current crisis of coffee production.

Similarly, external stakeholders note that PES has supported San Antonio's income. It facilitates community management, contributes to cushioning low coffee production, generates jobs (activities financed by the common fund) and promotes productive activities.

Social outcomes Sixty-two percent of the families know about the distribution of the financial resources received by the program. They explain that the decisions are made collectively in the assembly, and the money is distributed among the families (owners) and into a common fund to cover the general expenses of the community.

Local actors acknowledge contributions from PES programs in community organization (61%) and confidence among community members (58%). However, they mentioned that there is some division because not everyone agrees about the restrictions on the uses of natural resources decided within the general assembly and enhanced by PES schemes. There is also not full consensus regarding the distribution of financial resources, as some believe that all of the money must be divided among community members, and some respondents believe that more money should be allocated to the common fund.

The external actors emphasize that the PES program is looking the adaptation to the communities, and they mention the strengthening of public and common goods because PES income has been invested in access roads, acquisition of transport vehicles and construction of a communal store. It has also provided support for families who need health services in nearby cities.

3.3 Relationship between local context and PES outcomes

When we inquired openly about the causes of the perceived PES outcomes and the motivations for participating for more than 10 years in PES programs, the families declared that PES is an important source of economic support (40%), San Antonio has always had a tradition of preservation of natural resources (19%), and San Antonio has a decision-making process in which collective agreements are obeyed by all community members (12%).

When we asked about these causes through statements, 94% agreed that the community has strict agreements and rules regarding the use and management of natural resources; 91% agreed that the community has areas declared for use and conservation activities; 84% agreed that San Antonio has traditionally conserved its natural resources; and 74% agreed that families require additional income and that their community has strong confidence and internal organization.

The evidence shows the relevance of San Antonio's conservation tradition, the importance of the income generated and the roles of external agents, such as GeoConservación.

On the other hand, external actors emphasized the skills of local authorities, the strength of community organizations, the relative absence of serious internal conflicts, participation in regional organizations, such as Corenchi, the small size of the community, the high financial costs of deforestation, the role of GeoConservación as a provider of technical assistance, two-way PES money investments (common funds and distribution among community members) and the strict monitoring performed by CONAFOR.

Following the classification of variables proposed by McGinnis and Ostrom (2014), Table 5 compares the result of the focal context variables and the perceived causes of PES outcomes in San Antonio. It is possible to identify the close relationships between them because eight of the nine focal variables were reported as causes of PES outcomes.

4 Discussion

4.1 Local context variables

The nine focal variables selected allowed us to characterize the local context in San Antonio using the Ostrom SES framework, highlighting key elements such as a good level of conservation of cloud forests, a tradition of natural resource conservation reflected in the protection of forests for more than three decades, a strong organizational structure and strong enforcement of rules for natural resource usage.

Although the nine focal variables provide relevant information about local context, we now examine four new and important variables in the characterization of San Antonio's context. According to the SES framework, they are: (1) income; (2) the economic and conservation history of the community; (3) the presence and experience of external actors in conservation actions; and (4) distance to markets and urban centers. Figure 3 summarizes the 13 focal variables considered in the characterization of local context in San Antonio.

The current average income and the economic history of San Antonio emphasize, similar to many other indigenous communities in Oaxaca, coffee farming as the main economic activity, which was promoted in the 1950s due to strong interventions by the Mexican government. However, there has been a gradual decline in economic incentives, technical assistance and institutions created to promote coffee production (Morales 2013). Household income is steadily declining, and 75% of income now comes from federal government subsidies (Morales 2013).

Although coffee production is considered the main economic activity of many Oaxacan families, four subsidies are the principal income sources in San Antonio: a social inclusion program; support for agricultural producers; pensions for seniors; and the PES schemes.

In San Antonio, the biological diversity and the relevance of its ecosystem services have favored the constant presence of researchers and NGOs interested in natural resource conservation (Velasco et al. 2014). In the face of the coffee sector crisis, the livelihoods associated with the conservation of natural resources have been strengthened. Researchers and conservation NGOs have clearly influenced the development of San Antonio. The community statute, territorial planning and the National Agrarian Registry have been made possible by these collaborations, and there has been consistent participation in projects and conservation of community practices and social organization in favor of conservation, also contributing to the

Table 5 Focal variables of local con	text and causes of PES outcomes	
Focal variables	Local context in San Antonio	Stated causes of PES outcomes
Natural resources		
Forest cover	Well-conserved forest	1
Opportunity cost	Reduced opportunity costs given the tradition of natural resource conservation	Tradition in forest preservation and high financial costs of deforest- ing
Actors		
Livelihood	Reduced income, strongly diversified for self-consumption	Need to generate more family incomes
Pro-conservation attitudes	Recognition of direct, indirect and legacy values	From past generations San Antonio preserves its resources
Confidence and cooperation	Close bonds of trust and cooperation. Traditional voluntary cooperation practices rooted in the community	Strong confidence, and strong collectively work practices
Traditional management practices	Rules set out in the community statute and land use planning	Declared areas for use and conservation activities
Governance		
Internal organization	Strong internal organization, strong assembly and participation in the system of positions (cargos)	Decision-making process where collective agreements are obeyed by all community members
Land tenure	Collective land tenure, homogeneous distribution of land areas	Small size community with clear uses of territory defined
Rules for the management and use of natural resources	Clear rules sanctioned if they are unfulfilled	Strict sanctions described in community statute

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Influence of local context variables on the outcomes of payments...



Fig. 3 Focal context variables in San Antonio

increase in its regional and national prestige. The impacts of external actors are reflected in the processes of organization, planning of land use and relationships with natural resources. There are new questions emerging about the real impact of external actors, the nature of community agreements, and the real intrinsic motivations toward natural resource conservation.

Finally, the relative isolation of San Antonio is an important variable in its local context characterization. The distance to the markets and urban centers, lack of paved roads, lack of infrastructure (light, water), etc., have forced the residents to consolidate themselves as an independent community, auto-organized with strong social ties. These aspects have been relevant for food production for self-consumption and the conservation of natural resources.

However, there will be differences between communities in the Mexican experience, especially in Oaxaca; there are some similar examples. The analysis of the experiences in the Sierra Norte and Sierra Sur has recognized that the Mixe, Chinanteca and Zapotec communities have created successful forms of communal management of the forest. Research has shown that these achievements are due to the presence of ecosystem services of regional and national importance, solid social organization based on the system of uses and customs, the strength of the assembly for collective decisions, clear rules and sanctions, organized community with work without monetary compensation, the definition of functions within the community structure, and community territorial ownership (Toledo 1999; Sastre 2008; Carrasco and Barkin 2011).

4.2 Local context and PES outcomes

When we openly inquired about the main causes of or reasons for the PES outcomes and the constant participation in PES schemes and then when we organized the answers according to the SES framework, we found that eight of the nine focal variables of the local context

were included in the answers, making evident the relationship between these two groups of variables. This close relationship makes it possible to highlight once again the importance of the local context in the implementation of PES schemes, and at the same time, it allows us to identify some of the variables that must be considered in the design, implementation or modification of environmental public policy, recognizing the heterogeneity and relevance of local context.

In particular, the causes are related to: (a) low opportunity costs to conserve due to the community planning having established the rule not to deforest and due to elevated financial costs of timber harvesting. These conditions indicate that the area's dedication to conservation is not necessarily because of the program; (b) isolation of the community with respect to villages where commercial exchange occurs has the result that households' livelihoods are based on subsistence agriculture, and income is minimal, the land use change of forest land for another productive use not being a latent option for the comuneros; (c) pro-conservation attitudes, especially the tradition from past generations to preserve natural resources; (d) strong confidence and strong collective work practices; (e) traditional management practices, such as declared areas for use and conservation activities; (f) internal organization with decision-making processes in which collective agreements are obeyed by all community members; (g) the small size of the community; and (h) clear rules for land use and sanctions.

The environmental PES outcomes showed high recognition of PES contributions in community forest preservation and awareness of the relevance of forest protection, in line with the context variables "opportunity costs," "motivations and attitudes" and "traditional management practices," which reflect high the financial costs of deforestation, community traditions on natural resource preservation and territorial planning processes with voluntary protected areas.

The economic PES outcomes evidenced contributions to family and community incomes and their incidence in productive activities, in accordance with "livelihoods and income" context variable. In this particular case study, the program represents an important source of income for households due to difficulties in their principal economic activity (coffee production).

The social outcomes show that PES contributes to organization, confidence and public goods strengthening. These topics are aligned with context variables, such as "confidence and cooperation," "internal organization," "land tenure," "rules for the management" and "conservation history or historical continuity" related to local forest ecosystems. These actors and governance variables reflected in San Antonio a community with strong social capital, in which collective land tenure and the rules for resources management are respected.

Social capital has been highlighted not only as an outcome of PES (Molina et al. 2014; Hayes et al. 2015) but also as a precondition for PES success (Bray et al. 2012; Nieratka et al. 2015; Van Vleet et al. 2016). Therefore, if collective action is already present in the communities, PES outcomes will be more easily achieved, and if social capital is improving, the program is achieving a positive result. In the case of San Antonio, community rules and planning, as well as decisions made by the assembly, have allowed for conservation of the forest.

4.3 Natural resource conservation as an economic alternative

The analysis of the local context and PES outcomes in San Antonio generates discussion about the relationship between livelihoods (land area in productive activities and in natural resource conservation) and the average income. The results show the need to more deeply analyze the income structure and the weights of governmental subsidies, raising such new

questions as: How would the community persist without subsidies? What is the future of the forest without subsidies? Why do primary economic activities not consider conservation an economic alternative? Can conservation activities constitute a livelihood?

Our outcomes suggest a community in which conservation is a livelihood because of the people's experiences, traditions and norms. However, conservation is a livelihood poorly paid. Despite efforts, current conservation schemes in San Antonio do not offer real economic alternatives for families. These schemes partially address the financial problems in the short term. The consolidation of natural resource conservation, as an economic alternative or livelihood, like any traditional economic alternative, such as agriculture or livestock, requires permanent efforts by governmental and non-governmental institutions.

To contribute to the solution, we suggest three lines of action. First, if the opportunity costs are too low because of conservation traditions, another measure must guide the amount estimations of PES schemes, for example the promotion of a new sustainable livelihood.

Second, new financing sources are needed. Therefore, deeper analysis of the ecosystem service beneficiaries can claim the participation of more sectors, such as industries in the case of San Antonio.

The third alternative is to redirect the investment of PES income in search of sustainable economic activities, which could help households to develop equilibrium in productivity and preservation activities and sources of income, for example ecotourism, beekeeping, handcrafts, etc.

5 Conclusion

There is a close relationship between local context variables and PES outcomes. Eight of nine focal context variables were identified as relevant causes of PES outcomes, allowing us to demonstrate once again the importance of considering the local context, specifically the focal contextual variables determining PES outcomes.

While the local context might be broad and challenging to characterize, we have shown that the 13 focal variables (9 previously defined and 4 newly suggested variables) allowed us to define the context in San Antonio, and these variables are determinant of environmental, economic and social PES outcome perceptions (forest cover, opportunity costs, livelihoods, motivations and attitudes toward conservation, confidence and cooperation, traditional management practices, internal organization, land tenure and rules for the management and use of natural resources, income, economic and conservation history, presence of NGOs and isolation).

According to our suggestions, validation of the context variables and their relationships with the outcomes of PES as "outputs" of forestry SES could guide the design or redesign of environmental public policy instruments.

Finally, the analysis of local context and PES outcomes in San Antonio leads us to conclude that it is necessary to transform conservation activities into real economic alternatives. Conservation must cease to be a poorly paid livelihood. We identify three elements to advance this goal: new approximations of the opportunity costs and PES amounts; engagement of new users/buyers of ecosystem services; and redirection in PES income toward sustainable economic activities.

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