Assessing the effectiveness of Payments for Environmental Services in improving community-based forest conservation in Chiapas, Mexico

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Ph.D. Dissertation

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Para mi esposa y mi hija

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Peer-reviewed publications

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- "Efectivitat dels pagaments per conservar la biodiversitat a Mèxic", UAB divulga newsletter, November 2015
- Challenges ahead in impact evaluation: a workshop and a case study, INVALUABLE Newsletter n°3, April 2014

Abstract

A range of economic instruments aiming at stopping tropical deforestation has been implemented in developing countries over the past few decades. Among these, Payments for Environmental Services (PES, also called Payments for Ecosystem Services) have been theorized as contract-based mechanisms that provide incentives to better conserve forests in a cost-effective way. However, evidence about their performance is still recent and scarce, notably their environmental effectiveness but also their ability to induce forest managers' behavioral change and foster collective action between governmental agencies and community institutions for achieving long-term forest conservation.

This dissertation aims at evaluating the implementation of PES in collectively-owned forests in the state of Chiapas, Mexico. Specifically, it investigates i) if PES are generating additional forest conservation outcomes during contract implementation; ii) the influence of technical service providers over PES implementation; iii) what are the preferences of community members regarding PES contract characteristics; and iv) the extent to which community members are able to translate PES requirements into socially embedded and collectively enforced forest management institutions.

Data collection relies on both qualitative and quantitative methods, adopting a case-study approach that comprises several analytical scales: state, regional and community levels. A quasi-experimental approach based on matched control group and a difference-in-difference estimator is employed to assess the environmental additionality of PES within and across various communities involved in PES contracts. Results in this regard show that PES significantly contributed to reduce deforestation in a region characterized by high pressure on forests, even if some forests covered by PES have still been deforested during contracts.

As PES contracts are often negotiated by technical service providers, rather than by the participant communities and individuals, it is critical to understand how PES operational rules are transmitted when PES are implemented. Therefore, through data collected via semi-structured interviews and participant observation, PES implementation strategies of providers are described and problematized. Results highlight that not all intermediaries have an explicit strategy consisting in fostering the maintenance of forest conservation outcomes beyond contract duration. Nevertheless, providers with important organizational capacities and pursuing their own developmental or environmental objectives independently of the objectives of PES programs have the potential to incorporate PES into a broader intervention strategy.

Subsequently, the research explores the preferences of community members regarding PES contracts' characteristics through a choice modelling approach, since this allows understanding participants' preferences in PES participation and contract design. The analysis highlights that most community members strongly prefer individual contracts entirely in cash instead of contracts generating collective benefits but they are indifferent to the type of technical service provider (governmental official, independent consultant or community technician) supervising PES implementation. Nevertheless, an analysis of heterogeneity of preferences reveals that community leaders state a different pattern of preferences, as compared with those community members less involved in collective decision-making. This suggests that community leaders may have an influence in moderating preferences of their peers and enable or discourage collective participation in PES contracts.

This influence is further explored through semi-structured interviews and participant observation to understand how community leaders can articulate PES requirements with forest management institutions. Data reveals that leaders also have a critical role in motivating collective contract

compliance through the establishment of new forest management institutions. Nevertheless, PES appears insufficient to build the social capital needed to facilitate the individual appropriation and collective legitimacy of PES-induced forest management rules, raising doubt about the long-term environmental effectiveness of PES contracts in communities characterized by low levels of collective action.

Overall, the findings of this dissertation contribute to current debates on the environmental performance and social and institutional repercussions of PES. They suggest that PES can significantly reduce deforestation during contract implementation, but complementary policy-mixes are needed to institutionalize forest management rules both into community institutions and between community members, governmental agencies and other stakeholders. Strategies targeting community leaders to adapt PES contracts to social norms and institutional characteristics of communities may appear effective in the short-term but could also lead to degraded collective action if these leaders increase their privilege through their control of PES implementation. Although not all technical service providers have the capacity or the desire to supervise community participation and compliance, these actors are key to internalize PES incentives into the communities' social norms framing conservation and to coordinate a transformation of local institutions shaping forest management. Policy makers should therefore consider more context-sensitive PES implementation approaches to analyze and resolve failures in collective action and subsequently recraft institutional arrangements governing natural resources management. Interdisciplinary research frameworks could contribute to better understand the critical conditions enabling such institutional change through monetary incentives.

Keywords: Payments for Ecosystem Services, community-based conservation, effectiveness, forest management institutions, collective action, Chiapas, Mexico

Resumen

Varios instrumentos económicos diseñados con la finalidad de terminar la deforestación tropical, han sido puestos en práctica en países en desarrollo en estas últimas décadas. Dentro de esos instrumentos, los Pagos por Servicios Ambientales (PSA, también llamados Pagos por Servicios Ecosistémicos) han sido teorizados como mecanismos basados en contratos, que otorgan incentivos para conservar los bosques de manera costo-efectiva. Las pruebas del desempeño de los PSA son recientes y escasas, principalmente en relación su efectividad ambiental pero también en su capacidad de causar un cambio de comportamiento por parte de los usuarios de bosques y de mejorar la acción colectiva entre las agencias gubernamentales y las instituciones comunitarias, para lograr el mejoramiento de la conservación de los bosques a largo plazo.

Esta tesis doctoral pretende evaluar cómo se ponen en práctica los PSA en bosques con tenencia colectiva en el estado de Chiapas, México. En particular, esta tesis investiga: i) si los PSA generan conservación adicional de los bosques durante el tiempo del contrato; ii) qué influencia tienen los prestadores de servicios técnicos sobre la puesta en práctica de los PSA; iii) cuáles son las preferencias de los miembros de comunidades participantes sobre las características de los contratos de PSA y iv) cómo los miembros de comunidad participantes pueden transformar los requerimientos de los PSA en instituciones de manejo forestal socialmente aceptadas y colectivamente cumplidas.

Los resultados de la presente tesis contribuyen a debates actuales sobre el desempeño ambiental y las consecuencias sociales e institucionales de los PSA. Los resultados sugieren que los PSA pueden reducir significativamente la deforestación durante la vigencia de un contrato, pero que una mezcla de políticas complementarias es necesaria para institucionalizar un mejor manejo

forestal tanto a nivel intra-comunitario como en las relaciones entre miembros de las comunidades, agencias gubernamentales y otras partes interesadas. Solamente trabajar con líderes comunitarios para adaptar contratos de PSA a las normas sociales y a las características institucionales de las comunidades, puede parecer efectivo a corto plazo, pero podría también deteriorar la acción colectiva si los líderes acumulan privilegios a través del control que ejercen sobre la puesta en práctica de los PSA. Cabe subrayar también que, a pesar de que no todos los prestadores de servicios técnicos tengan la capacidad o el deseo de supervisar la participación colectiva y el cumplimiento de los PSA, éstos son actores claves para internalizar los incentivos derivados de los PSA dentro de las normas sociales y comunitarias, permitiendo la conservación de los bosques y coordinando la transformación de las instituciones locales que organizan la conservación de los bosques. Los legisladores deberían proponer PSA más adaptados a los contextos locales que permitan analizar y resolver las fallas de acción colectiva y reforzar los arreglos institucionales qué organizan el manejo de los recursos naturales. La investigación interdisciplinaria puede permitir entender mejor las condiciones favoreciendo tal cambio institucional a través de mecanismos basados en contratos.

Palabras claves: Pagos por Servicios Ambientales, conservación basada en comunidades, efectividad, instituciones de manejo forestal, Chiapas, México

Content

Tables

Figures

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Acronyms

ASIRMI	*Asociación de Silvicultores Región Miramar*
	Sylvicultural Associacion of the Miramar Region
CBC	Community-based conservation
CBNRM	Community-based natural resource management
CONABIO	*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad*
	Mexico's National Comission on Biodiversity
CONAFOR	*Comisión Nacional Forestal*
	Mexico's National Forestry Comission
CONANP	*Comisión Nacional de Áreas Naturales Protegidas*
	Mexico's National Comission on Natural Protected Areas
ECOSUR	*El Colegio de la Frontera Sur*
	The Southern Border University
FAO	Food and Agriculture Organization of the United Nations
FONCET	*Fondo de Conservación El Triunfo*
	Conservation Funds for the region El Triunfo
ICDP	Integrated Conservation and Development Projects
INEGI	*Instituto Nacional de Estadística Geografía y Informática*

	Mexico's National Institute of Statistics
INECC	*Instituto Nacional de Ecología y Cambio Climático*
	Mexico's National Institute of Ecology and Climate Change
IUCN	International Union for the Conservation of Nature
LGDFS	*Ley General de Desarollo Forestal Sostenible*
	Mexico's General Law on Sustainable Forestry Development
MBI	Market-Based Instrument
MEA	Millennium Ecosystem Assessment
PES	Payment for Environmental Services
PROCEDE	*Programa de Certificación de Derechos Ejidales y Titulación de Solares*
	Land rights certification program
PSAH	*Programa de Servicios Ambientales Hidrológicos*
	Payments for Hydrological environmental services
PSA-CABSA	*Programa para Desarrollar el Mercado de Servicios Ambientales por Captura de Carbono y los Derivados de la Biodiversidad y para Fomentar el Establecimiento y Mejoramiento de Sistemas Agroforestales*
	Payments for Carbon, Biodiversity and Agroforestry Systems envirionemntal services
RAN	*Registro Agraria Nacional*
	Mexico's National Agrarian Registry

REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing countries
SAGARPA	*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación* Mexico's Ministry for Agriculture
SEDESOL	*Secretaría de Desarrollo Social* Mexico's Minsitry of Social affairs
SEMAHN	*Secretaría de Medio Ambiente e Historia Natural* Secretariat of Environmental protection and Natural History of Chiapas
SRA	*Secretaría de la Reforma Agraria* Mexico's Secretariat for Agrarian Reform
TEEB	The Economics of Ecosystem and Biodiversity

1. Introduction

1.1 Research background

Deforestation rates have been stabilized at global level for a decade but they remain important in tropical forests (FAO 2015; Smith et al. 2014). Deforestation has complex causes but generally results from the behavior of actors adapting to economic and policy opportunities (Angelsen and Kaimowitz 1999; Geist and Lambin 2002). Human-induced land-use change is the major driver of tropical deforestation, mainly due to agricultural and livestock expansions but also because of mining and urbanization (Busch and Ferretti-Gallon 2017). Deforestation threatens human livelihoods, locally and globally, due to ecosystem services losses (Millennium Ecosystem Assessment 2005; TEEB 2010) including by destroying refuges of biodiversity (Gibson et al. 2011) and disturbing biogeochemical cycles such as rainfall and carbon, leading to an alteration of the global climate (Mahmood et al. 2014).

Forest conservation policies have been increasingly promoted by governments, NGOs and international organizations all over the world. Conservation policies can be defined as institutions aiming at influencing how forest resources are managed and accessed by local individuals and communities or other actors. Conservation policies generally result from the willingness of some social actors (e.g. downstream water users, governmental agencies or international organizations) to improve or maintain the flows of some ecosystem services provided by forest resources (e.g. aesthetics, biodiversity preservation, water protection or carbon sequestration) according to a specific valuation language (e.g. intrinsic values or monetary evaluation of ecosystem services). The purpose and framing of conservation policies has evolved over the years, notably following different conceptions of the relationships between people and nature (Mace 2014). It is worth noting that conservation science and practice have historically been characterized by cyclical apparition of new paradigms allegedly able to

address many contemporary societal challenges, while their respective performance have generally been judged disappointed few years later, especially if new paradigms have emerged (Redford and Adams 2009).

While there is still no agreement about what are the best policies to conserve forests, several types of instruments have been implemented, in function of the theoretical and empirical advancements of conservation science but also in correspondence with the evolving agenda of conservationist organizations (Mascia et al. 2003). Conservation often consist in limiting access to resources to some actors but increasingly also include various forms of forest management (e.g. facilitating natural regeneration of trees, preventing fire and pests, patrolling to prevent illegal extraction...,). At global level, forested landscapes are characterized by heterogeneous degrees of conservation (e.g. no protection at all, some restrictions favoring sustainable forest management or strict conservation), considering how combinations of land-use regulations and other public and market incentives are able to effectively address the drivers of deforestation (Lambin et al. 2014).

Protected areas remain nowadays a central instrument for forest conservation, representing more than 11,5% of the terrestrial surface (Naughton-Treves, Holland, and Brandon 2005; Mace 2014). The ability of protected areas to stop deforestation has been criticized, notably when they consist in top-down and bureaucratic initiatives imposing strong social costs on people living near or within protected areas or when they are "paper parks", legally considered as protected areas but with limited operational capacities. Since the 1980's, conservation policies have occasionally tried to better involved local people in conservation and some conservationists have argued that "win-win" interventions articulating conservation policies with side objectives such as rural development and poverty eradication can be achieved. However, many of these projects have failed to effectively rely on participative approaches and critics have pointed out that many of these instruments require continuous flows of financial

support for limited visible results (Naughton-Treves, Holland, and Brandon 2005). Therefore, the ability of these initiatives to reach either conservation or development goals has been questioned, and their impacts have often lagged behind expectations.

Drawing of the unfulfilled promises of past conservation initiatives, scholars and practitioners have looked for innovative ways to better incentivize the adoption of conservation practices by local individuals and communities. Environmental economists have claimed that conservation policies should generate additional conservation outcomes and induce permanent behavioral change in order to reach the maximum impact given a limited available budget (Ferraro and Kiss 2002; Jack, Kousky, and Sims 2008). Payments for Environmental Services (PES, also called Payments for Ecosystem Services) have been theoretically conceived to avoid land-use change through direct but conditional incentives. PES programs are based on delivering (most often) economic rewards to voluntarily forest managers, who should in exchange perform several conservation activities eventually defined in a forest management plan. PES implementation is often supervised by technical assistants able to articulate contract requirements with the preferences of local forest managers and facilitating contract compliance and monitoring. However, PES are rarely designed as a cost-effective conservation instrument but rather often functions as a transfer of resources expected to contribute to several environmental and social goals.

PES programs targeting deforestation have been implemented in both developed and developing countries (Engel, Pagiola, and Wunder 2008; Ezzine-de-Blas, Wunder, et al. 2016). Their instrumental logic ("paying people to conserve forests") has nevertheless generated controversies. It has been argued that putting a price on nature by commodifying ecosystem services oversimplify the complexity of socio-ecological systems by imposing a monetary valuation language eventually detrimental to other valuation languages used by other stakeholders. PES are therefore occasionally considered as vehicles to "neoliberalise Nature"

through market-based mechanisms, an approach that bear the risk of exacerbating inequalities in the distribution of environmental costs and benefits by favoring the benefits of some powerful actors at the expense of those supporting the social costs of conservation (Büscher 2012; McAfee 1999).

This dissertation does not engage all the debates regarding the theoretical perspectives and the global effects of PES. Instead, the research carried out try to examine how PES can contribute to reach the desired conservation goals when there are implemented among forests owned by rural communities. Many doubts subsist over the ability of PES to induce the desired behavioral change among local forest-owners while providing incentives complementing pre-existing governmental regulations and community institutions shaping local forest management. Debates have particularly considered the cases where monetary incentives can eventually undermine social norms and motivations enabling collective action, subsequently leading to less cooperation between community members over the collective management of forest resources. As a significant proportion of tropical forests are owned by rural communities, understanding under which conditions monetary incentives can improve local systems of collective management could allow policy makers to better articulate forest conservation goals with the preferences of local community members and improve collective action between actors located at different scales.

1.2 Objectives of the dissertation

The objective of this dissertation is to investigate the ability of PES to enable additional forest conservation while strengthening collective action across scales. The research is notably focused on how monetary incentives can contribute to align forest management practices of community members with social interests expressed by governmental agencies. It reflects on the possibility of community members, helped by technical assistants, to adapt to and comply with PES contract terms but also in appropriating forest management techniques and improving

their own social organization in order to strengthen forest management institutions, a condition permitting reaching long-term forest conservation goals. The dissertation therefore pay attention to the actors involved in PES implementation but also on their ability to (re-)craft multi-scale forest management institutions and improving cooperation and coordination of actors across scales.

In responding to these interrogations, it adopts a case-study approach in the state of Chiapas, Mexico considering several PES programs sponsored by the federal government. Mexico has been a pioneer in the implementation of one of the world's largest governmental PES programs since 2003. Nowadays, PES programs in Mexico encompass various modalities such as two federal schemes respectively targeting hydrological and biodiversity conservation services, but also local outsourced PES mechanisms and early REDD+ actions. Simultaneously, Mexico also have the particularity of having a considerable proportion of its forests owned and managed by rural and indigenous communities. The state of Chiapas has been particularly represented among PES participants, notably due to the importance of its forests for the generation of ecosystem services targeted by governmental agencies but also because of the important deforestation trends occurring in this state. The dissertation is organized around three distinct analytical scales (state, sub-state region and community scales) explored through four main research questions:

Does Mexico's PES biodiversity conservation program result in additional forest conservation outcomes?

This question is addressed in Chapter Three and is answered by proposing a methodology able to measure additional forest conservation generated by PES when these programs are implemented in community contexts. The methodology consists in the definition of a counterfactual allowing to disentangle the impact of the PES programs from other contextual factors also influencing forest conservation outcomes. Findings show that PES generate

considerable additionality in a region characterised by important pressures on deforestation. Results nevertheless also highlight that deforestation has still occurred within parcels covered by the program, and it suggests that PES alone might be insufficient to effectively stop deforestation beyond contract duration.

How do technical service providers adapt to and influence PES implementation in rural communities?

This question is answered in Chapter Four by exploring the challenges faced by technical service providers involved in the implementation of various PES modalities across the state of Chiapas. This chapter investigates the different motivations and organizational characteristics characterizing these actors and examines how these differences are associated with different criteria for selecting participants and implementing PES. This chapter also discusses how inequalities in the access to PES programs might be amplified by the ability of some service providers to concentrate PES contracts in their own area of influence.

What characteristics of the contract increase the willingness of individual community members to participate collectively in PES?

This question is answered in Chapter Five using a Choice Experiment questionnaire among PES participants in a community in Chiapas. Choice Experiments allow to elicit individual preferences regarding the characteristics of PES contracts. The tested characteristics are i) who is involved in deciding the parcels to be including in the contract, ii) what type of technical service provider is preferred, iii) the level of payment and iv) the type of incentive (either in individual cash payments or in collective investments). An analysis of heterogeneity of preferences is also carried out in order to provide insights on which individual and community factors might be explaining such preferences. The findings suggest that it is important to

consider the preferences of participants, particularly when a PES contract is renewed, in order to better adapt contract terms with local institutional and social characteristics.

How do PES interact with community forest management institutions and affect collective action?

This question is answered in Chapter Six by collecting data in the same community than in Chapter Five. The chapter describes forest management institutions existing in the community prior to PES implementation and discuss the degree to which PES has enabled the creation of new forest management institutions motivating forest conservation. Findings shed light on the fact that these new institutions entail the extension of the domains covered by collective action in the community, which partially contracting some community social norms. The resulting conflicts illustrate that PES might not been sufficient to guarantee the stability of these new forest management institutions if the institutions have not been negotiated through a participative process.

1.3 Outline of the dissertation

This dissertation is divided into seven chapters, including this introduction. Chapter Two introduces the evaluative framework used to assess PES effectiveness when implemented in forests owned by communities. The evaluative framework consists in a theory of change exploring through which processes PES can generate additional forest conservation outcomes while improving collective action across scales. The chapter also presents the case study and the research strategy used to answer the research questions. It presents contextual characteristics of forest conservation in Mexico and specifically explains the evolution of PES programs in this country. It also provides information about how PES have been implemented in the state of Chiapas and details the analytical scales used in this dissertation.

Chapter Three answers the first research question by assessing PES effectiveness in a region of Chiapas characterized by important deforestation trends and where numerous PES contracts have been implemented since 2005. Using a counterfactual obtained from a covariate matching method and a difference-in-difference estimator, the chapter demonstrates that PES contracts can generate important additional forest conservation, even if deforestation still occurs within forests included in PES contracts. This chapter subsequently discusses the findings in relation with other studies measuring PES effectiveness counterfactuals, specifically in the cases of PES implemented among rural communities.

Chapter Four answers the second research question through the qualitative analysis of data collected among many of the technical service providers in charge of PES implementation in the state of Chiapas. The results show that service providers differ considerably in terms of motivations and organizational characteristics. These differences are associated with different strategies to adapt to changes in PES procedural rules but also in interacting with complex community contexts. Some providers have defined strategies to mainstream PES into rural communities but not all intermediaries have the same organizational capacities to develop such strategies. Consequently, PES implementation is influenced by providers in aspects such as the spatial concentration of PES contracts, notably in areas characterized by stable PES funding sources, but also how providers are able to use PES incentives to generate motivations to recraft collective management institutions at community and supra-community levels. The findings are discussed by considering how this heterogeneity of capacities affects the access to PES programs for communities located in areas away from the sphere of influence of powerful service providers.

Chapter Five answers the third research question through a Choice Experiment exploring the preferences of participants over PES contract terms. Results highlight that most participants prefer individual contracts entirely in cash to any other contracts based on collective

participation or benefit-sharing, including if PES foster investment in collective productive projects. However, analysis of preference heterogeneity reveals that community leaders state a different pattern of preferences more favorable to collective participation, as compared to non-leaders. Therefore, community leaders are likely to moderate individual preferences and foster the collective participation to PES. The findings are discussed by considering how individual and community characteristics influence individual preferences and it is suggested that tools such as Choice Experiments can contribute to improve the implementation of PES at community level if they allow to better understand the local social and institutional factors preventing the willingness to collectively participate to PES programs.

Chapter Six answers to the fourth research question by analyzing how community members have tried to adapt PES to their community institutions. As PES require collective action in domains previously managed individually, social capital has to be mobilized to enable compliance to PES contracts but also to allow the establishment of new stable forest management institutions. However, PES have been associated with new prerogatives to community authorities but have failed to rely on participative decision-making processes. These findings are discussed by considering how some leaders can have the agency to mobilize social capital, but that the levels of social capital might be too weak to be conducive to collective action and better forest conservation outcomes.

Chapter Seven concludes the dissertation by synthetizing the theoretical and methodological contributions. It also provides policy recommendations and proposes a reflection on further research needed to better understand the conditions under which PES programs can lead to long-term forest conservation outcomes when implemented among rural communities.

2. Theoretical and methodological foundations

2.1 Payments for Environmental Services and collectively-owned forests

2.1.1 What are Payments for Environmental Services?

PES programs can be defined as voluntary transactions between service users and service providers, in which payments are transferred in exchange for agreed rules of natural resource management expected to provide offsite environmental services (Wunder 2015). Various definitions of PES nevertheless exist in the literature, and they may vary in terms of program scopes and conceptualization of their functioning (see e.g. Wunder 2005; Muradian et al. 2010; Sommerville, Jones, and Milner-Gulland 2009; Tacconi 2012).

Wunder notably initially considered that genuine PES should met five criteria: (1) a voluntary transaction where (2) a well-defined environmental service (or a land-use likely to secure that service) (3) is being bought by a (minimum one) environmental service buyer (4) from a (minimum one) environmental service provider (5) if and only if the environmental service provider secures environmental service provision (conditionality) (Wunder 2005). The framing of this definition implies that PES programs are supposedly appropriate as a classical Coasean-type approach to deal with environmental externalities (Engel, Pagiola, and Wunder 2008). The Coase theorem states that, in a context where property rights are well defined and transaction costs are sufficiently low, an agreement between involved actors (e.g. users and providers of environmental services) can lead to a mutually beneficial transaction (Muradian et al. 2010). Environmental economists have indeed argued that deforestation is explained by failure of markets to take into account the total costs of land-use changes (Landell-Mills and Porras 2002; Pearce 2002): losses of environmental goods and services provided by forest ecosystems are "externalized", so forest-owners decisions can lead to a reduction of society welfare (Engel et al., 2008; Jack et al., 2008). Halting deforestation thus can be achieved by "internalizing" those

costs, i.e. re-crafting economic incentives to motivate forest-owners to maintain the provision of ecosystem services (Busch and Ferretti-Gallon 2017; Muradian et al. 2010).

However, the Coasean nature of PES programs has been questioned on the grounds that PES often operate in complex institutional contexts characterized by important transaction costs, unequal power relations and uncertainties regarding the provision of environmental services (Vatn 2010; Muradian 2013). Therefore, not all actors are endowed with the same negotiating power, and, in practice, PES are often set-up by organizations such as governments or non-state civil society actors, including NGOs and private companies. PES are often defined by ecological economists in a broader sense than Wunder (2005): "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"(Muradian et al. 2010). This definition insists on the fact that PES are rarely operating as pure markets but often rely on hybrid governance system combining features from both hierarchical (e.g. state control) and decentralized (e.g. markets) governance systems (Muradian 2013). This dissertation does not engage all the theoretical debates surrounding the definitions of PES but consider that PES differ from other conservation instruments because they rely on positive conditional incentives (Ezzine-de-Blas et al. 2016; Engel, Pagiola, and Wunder 2008).

PES programs targeting deforestation have been implemented in both developed and developing countries (Engel, Pagiola, and Wunder 2008; Sattler and Matzdorf 2013). Across the world, PES have notably targeted a range of ecosystem services, including watershed regulation, biodiversity conservation, carbon sequestration, or multiple bundled services (Muradian et al. 2010; Engel, Pagiola, and Wunder 2008; Ezzine-de-Blas et al. 2016). PES schemes differ in their underlying institutional frameworks and implementation scales: while some are built upon complex institutions that articulate the quantification and exchange of well-

defined services, such as payments connected with global carbon markets, other schemes rely on flexible, or project-based institutional frameworks (Buttoud 2012; Corbera 2012).

Monetary payments are often conditioned to the to the design and implementation of agreed-upon forest management rules and activities, often taking the form of a forest management and conservation plan containing scheduled conservation activities (e.g. land-use planning, fire prevention activities, adoption and enforcement of new local rules related to access to forests,…) during the defined time of the contract (McElwee 2012; Milne and Adams 2012; Shapiro-Garza 2013). A participatory, locally-suited, design of the forest management plan, notably supervised by a forest consultant acting as technical intermediary, is expected to turn PES requirements into sustained behavioural change leading to better forest conservation outcomes (Clements et al. 2010; Kosoy, Corbera, and Brown 2008; Rico García-Amado, Ruiz Pérez, and Barrasa García 2013).

Many programs related to tropical forests are funded by national governments (Calvet-Mir et al. 2015; Farley and Costanza 2010). Governmental PES are commonly used as a vehicles for multi-purpose interventions linked to broader rural development policies, including poverty alleviation (Engel, Pagiola, and Wunder 2008; Muradian et al. 2010; Schomers and Matzdorf 2013). PES can notably be used as part of a policy mix of larger conservation strategies such as in national systems of protected areas or those envisaged in REDD+ national projects (Angelsen and Rudel 2013; Buttoud 2012; Joppa and Pfaff 2011).

2.1.2 The implementation of PES in collectively-owned forests

Forests managed by communities represent nearly 18% of the global forest area (Sunderlin et al. 2008; White and Martin 2002; Chhatre and Agrawal 2008). Forest communities encompass various tenure regime characterised by the property rights conferred by the respective national governments (Schlager and Ostrom 1992). One the one hand, around 11.5% of forests

worldwide are privately owned by rural or indigenous communities, i.e. they have rights to access, sell or otherwise alienate, manage, withdraw resources and exclude outsiders, and in principle governments cannot terminate those rights unilaterally. On the other hand, many communities only have the rights to use forest resources but not to sell or alienate these resources and the governments maintain strong prerogatives over the management of forests (Sunderlin et al. 2008; White and Martin 2002). In this dissertation, the words "community" and "common property" are used interchangeably to refer to communities holding private property rights, although in many national legislations governments retain regulative power over forests while recognizing communities as rightful owners.

Many PES programs targeting forest conservation take the form of community-based or collective payments, mostly in developing and emerging countries such as in Africa (Brimont and Karsenty 2015; Namirembe et al. 2014; Nelson et al. 2010), in southeast Asia and China (Clements et al. 2010; McElwee 2012; Yang et al. 2013) or in Latin America (Hayes et al. 2014; Kosoy, Corbera, and Brown 2008). Such contracts are generally expected to provide several other co-benefits such as secure property rights, better income and also improved trust and recognition between government agencies and community members (Greiner and Stanley 2013). PES can therefore contribute to better embed forest management institutions into community institutions, notably through monetary incentives, technical assistance and participatory processes stimulating the collective capacities to adopt and enforce forest conservation rules (Clements et al. 2010; Hayes, Murtinho, and Wolff 2015; Kosoy, Corbera, and Brown 2008).

Evidence of the effectiveness of collective PES in improving forest conservation outcomes are emerging. Impact assessments of collective contracts have been carried out in Mexico (Alix-Garcia, Shapiro, and Sims 2012; Alix-Garcia, Sims, and Yañez-Pagans 2015; Honey-Rosés, Baylis, and Ramirez 2011; Sims and Alix-Garcia 2016), China (Yang et al. 2013), and

Cambodia (Clements et al. 2013; Chervier and Costedoat 2017). They suggest a positive, but generally small, impact on forest conservation, which is consistent with empirical evidence available in other tenure contexts (Börner et al. 2017; Miteva, Pattanayak, and Ferraro 2012; Samii et al. 2014).

Social impacts of PES, notably in relation with equity are more ambiguous, due to the lack of research frameworks allowing the comparability of evidences between different contexts (Calvet-Mir et al. 2015). Overall, there is still insufficient evidence about the suitable conditions under which PES are likely to be avoid deforestation and notably how PES can generate long-term conservation impacts without negatively affecting social cohesion and cooperation between stakeholders involved in forest management.

The following section clarify the definition of PES effectiveness used in this dissertation and introduce forest management institutions as a concept able to understand how PES can induce long-term forest conservation.

2.2 Environmental effectiveness and forest management institutions as research concepts

2.2.1 Defining PES environmental effectiveness

PES are environmentally effective if they directly contribute to avoid losses of environmental services, i.e. if, in comparison with a situation without PES, the programs have induced a reduction of these losses (see section 2.3 for a presentation of the framework used to measure PES effectiveness). An effective PES should notably contribute to improve forest conservation outcomes, understood here in terms of lower annual deforestation rate or stable forest cover. As an outcome, forest conservation is directly influenced by PES program. However, forest conservation is also the result of the interaction between many other institutional, economic, social and cultural factors. Therefore, a PES is effective if it generates additional conservation outcomes, i.e., after considering all the factors influencing conservation, PES implementation

generate better outcomes as compared to a situation without PES. Therefore, assessing PES effectiveness does not simply measure forest conservation outcomes but rather try to compare observed outcomes in forests included in PES contracts to outcomes in forests not included in contracts, given that both included and no included forests are similar enough prior to PES implementation (a methodology to assesses additionality is provided in Chapter 3).

In this dissertation, additionality is considered as equivalent to the short-term environmental effectiveness of PES, i.e. how PES has generated a result in terms of forest conservation during contract duration. A difference is made with the long-term effectiveness, which corresponds to the capacity to avoid deforestation beyond contract duration. Long-term effectiveness is considered as the impact of PES programs, following the terminology used in evaluations. The links between short-term and long-term effectiveness are not straightforward (Börner et al. 2017), notably if PES insufficiently addresses the drivers of deforestation or if the incentives provided by PES are not maintained. Deforestation can indeed occur if the effects of PES are not permanent: if PES contracts end, forest-owners might be tempted to deforest plots previously covered by PES if no liability is attached to these plots. PES can also create unattended opportunities for deforestation known as spillover effects (e.g. leakages, the spatial displacement of deforestation from plots included in PES contracts to plots not included or rebound effects corresponding to the adoption of new deforestation practices because of the new sources of income constituted through PES payments). In this dissertation, only the short-term effectiveness is directly measured (Chapter 3) but some factors constituting barriers to long-term effectiveness are discussed along chapters Four, Five and Six. The theoretical framework presented in section 2.3 precise the links between PES and long-term effectiveness.

Overall, PES effectiveness depends on many factors, notably related to i) the social, environmental, economic and political contexts where they are implemented (often affected by the characteristics of ecosystem services, property rights and heterogeneous levels of social

capital between involved actors), ii) specific program design notably related to the definition of eligibility and priority areas and the allocation of budget allowing the well-functioning of PES and iii) the way they are implemented, i.e. how in practice PES are able to involve the participation of relevant social actors to reach the desired program goals (Jack, Kousky, and Sims 2008; Kemkes, Farley, and Koliba 2010; Börner et al. 2017).

In practice, actors willing to pay for conservation have empirically addressed many of these factors in the definition and implementation of PES programs procedural rules. Procedural rules often explicitly define aspects such as the targeting of relevant eligibility areas for the provision of environmental services; the identification of beneficiaries (e.g. a landowner, a group of landowners, or a rural community); the activities beneficiaries need to comply with to receive payments; the compensation amount (i.e. more or less money and/or other type of monetary incentives); the frequency and duration of payments (i.e. more or less years); the way in which such compensation is transferred from payees to beneficiaries (e.g. with a lower or higher degree of intermediation and the eventual importance of technical assistance) and the respect of conditionality through monitoring and sanctioning (Ferraro 2008; Jack, Kousky, and Sims 2008; Muradian et al. 2010; Schomers et al. 2015).

The links between PES and the desired environmental outcomes are also affected by complex interactions inherent to any interventions affecting one or several variables of socio-ecological systems (Corbera, Brown, and Adger 2007; Pascual et al. 2014). Socio-ecological systems indeed encompass multiple interactions between resources, users and governance systems, in turn producing outcomes both within and beyond a given socio-ecological system (Ostrom 2009). The environmental effectiveness of PES can notably be affected if PES undermine social relations governing the management of natural resources, e.g. if they increase inequalities in power relations or in the access to some resources, or if they deteriorate the motivations to cooperate with other actors. PES are therefore more likely to produce the desired environmental

outcomes if they are based on a legitimate implementation process generating equitable social outcomes (Pascual et al. 2014; Muradian et al. 2010).

2.2.2 The importance of forest management institutions in conservation

The perceptions of the role of communities in natural resource management and conservation has considerably evolved these last decades. Influential works such as "the Logic of Collective Action" (1965) by Mancur Olson or the publication in 1968 by Garret Hardin of "The Tragedy of the Commons" have theorized that difficulties to act collectively and demographic pressures are likely to lead to the degradation of natural resources owned by communities. However, the role of communities on resource management has been revised positively since the end of the 1980's (Agrawal and Gibson 1999; Ostrom 1990). The rich literature on the management of commons has notably highlighted that, depending upon certain conditions, community members can craft themselves stable institutions incentivizing the collective management of natural resources. Collective management of natural resources, including forest management and conservation, has been thoroughly researched (e.g. Ostrom, 2009; Wollenberg, 1998) and there exists an ample consensus that such management is likely to be more sustainable if the spatiality and boundaries of the resource are well-known to users; if the physical distance between the users and the resource is small; if the users' group is small; if the shared management rules are clear and legitimate and if external actors do not challenge such rules (Agrawal 2001).

In principle, community property regimes lay on a bundle of rights conferring a certain degree of autonomy to rightholders in deciding how benefits are derived from their natural resources (Ribot and Peluso 2003; Schlager and Ostrom 1992). This autonomy eventually allows community members to engage in cooperation based on rules and norms favouring reciprocity (Berkes 2007, 2004). Nevertheless, not all communities are characterised by important levels of cooperation, and cooperation in itself is not necessarily leading to better forest conservation

outcomes (Agrawal and Gibson 1999). In that context, governments often try to influence forest management outcomes by setting up rules and procedures defining the rights and duties of the social actors involved in forest management.

This dissertation uses the concept of forest management institutions that can be defined as multiscale arrangements where a government define the procedures to create local use and management rules, but also recommend procedures allowing to implement these rules (notably through monitoring and sanctions) and resolve disputes (Agrawal and Gibson 1999; Adger, Brown, and Tompkins 2005). These institutional arrangements notably aim at coordinating the behaviours of these social actors located at different geographical scales[1]. The challenge for policy makers is then to understand how to define forest management institutional arrangements that can be appropriated by community members, collectively enforced with limited intervention of external actors and conducive to the desired conservation outcomes without aggravating inequalities or undermining social organization (Barrett et al. 2001; Pretty 2003). However, these institutions are not easily crafted because community members rarely recognize as legitimate all institutional arrangements sponsored by the government, especially if community members already have institutions more aligned to their individual and collective preferences (Cleaver 2002).

Overall, there is generally a lack of evidence about the ability of PES to influence the creation or the development of lasting forest management institutions enhancing forest conservation outcomes and collective action (Cardenas, Stranlund, and Willis 2000; Muradian et al. 2013). In some contexts, PES can undermine motivations to cooperate because monetary incentives

[1] In this dissertation, scale is understood in a spatial sense and specifically refers to the complexity of coordination between decisions at national level and behaviours at community level. Many social actors operate at the interface between these two levels, and phenomena occurring at some scales may be affected by phenomena located at other scales. This dissertation specifically considers three analytical scales described in section 2.4.

change how conservation is perceived by PES participants: while conservation was mostly supported by social norms, introducing a payment for conservation could induce the adoption of materialistic motivations to conserve, reducing reciprocal cooperation with other community members and increasing the dependence to externa payments (Rode, Gómez-Baggethun, and Krause 2015; Cardenas, Stranlund, and Willis 2000; Rico García-Amado, Ruiz Pérez, and Barrasa García 2013). As well, PES implementation can strengthen intra-community inequalities because only some individuals or groups have access to decision-making and therefore PES increase power imbalance (Kosoy, Corbera, and Brown 2008; Milne and Adams 2012).

Therefore, there can be trade-offs between the environmental effectiveness of PES and other outcomes, notably if PES implementation is not conducive to a strengthening of forest management institutions consisting in better collective action between community members, the internalisation of forest conservation as a collective interest and the coordination of community members with government officials. The complex interactions between these processes and forest conservation outcomes nevertheless require the definition of a theoretical framework describing how PES can generate forest conservation outcomes while improving collective action of social actors involved in forest conservation across scales.

The following section clarify the links between environmental effectiveness and forest management institutions by proposing a framework explaining how PES can lead to better forest conservation outcomes and impacts.

2.3 A theoretical framework linking PES and forest management institutions

This dissertation understands long-term forest conservation as the product of cross-scale collective action (i.e. both cooperation between community members and coordination between

community and government levels). In turn, cross-scale collective action is enabled by the presence of stable and legitimate forest management institutions.

While PES can in principle help community members to adapt forest management institutions to their preferences, notably embed them within other community institutions, community members often lack the willingness or the capacity to do so. Furthermore, any change of rules does not necessarily affect all sub-community groups in the same way, notably if each group of interests is not well represented in decision-making, therefore many communities can be characterised by conflictual relations instead of cooperation. Institutions may be constantly challenged because affected individuals may want to renegotiate them (Klooster 2000; Ishihara and Pascual 2009).

As communities are made up of individuals with different interests and unequal access to power and resources, some community members can try to maintain or increase their privileges, such as accumulating prestige and influence or controlling benefit-sharing (Corbera, Brown, and Adger 2007; Ishihara, Pascual, and Hodge 2017; Milne and Adams 2012). However, forest management institutions are likely to be more effective and legitimate if responsibilities are shared between the different actors involved in forest management (Pascual et al. 2014; Berkes 2004). It is therefore important that forest management institutions complement and interact with other institutions, such as property rights, collective decision-making processes and other social norms accepted by the majority of community members (Cleaver 2002; Poteete and Ostrom 2004).

Some social actors can have the human agency (understood as leadership) to articulate a change of institutions by accommodating the interests of the various social actors affected by such change. To do so, these agents should mobilize social capital. Social capital is often defined as the relations of trust and reciprocity enabling exchange within a network of actors sharing similar social norms, and therefore appears as a necessary condition to facilitate the emergence

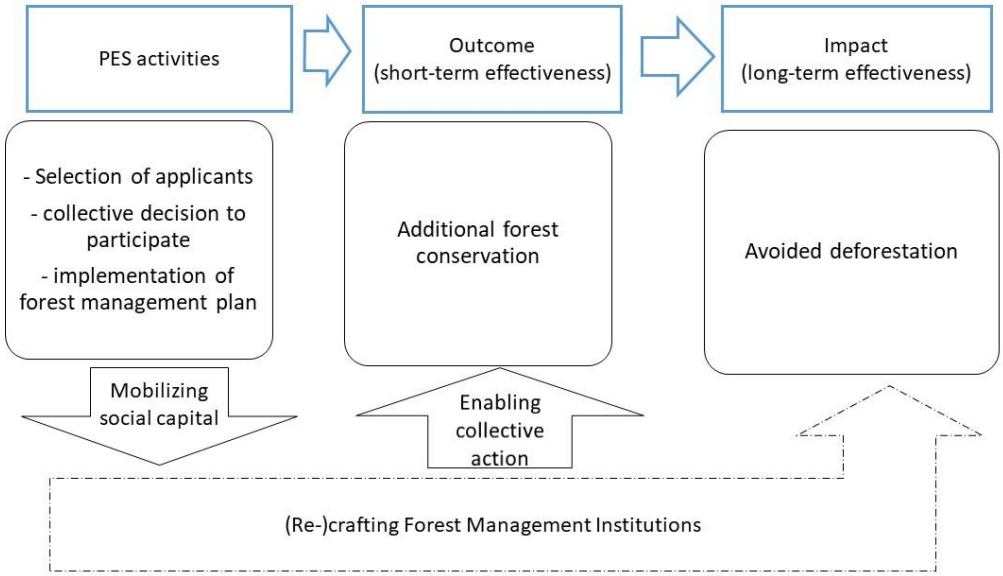
of stable institutions (Adger 2003; Folke et al. 2005; Giest and Howlett 2014; Pretty 2003). Social capital allows community members to collectively engage in effective and legitimate actions (Nieratkaa, Bray, and Mozumder 2015; Pretty 2003) as far as there is a shared common understanding of what constitutes collective interests and how to contribute to it (Chwe 1999; Cleaver 2002; Ishihara and Pascual 2009).

Among the actors who can influence forest management institutions, community leaders can accommodate divergent interests and resolve conflicts, constructing the meaning and rationale of some decisions and setting up collective forest management rules perceived as legitimate by community members (Olsson, Folke, and Berkes 2004). Community leaders can be traditional, elected and entrepreneurial individuals. Their leadership skills are not necessarily associated with a formal position they hold but rather by their influence within a network of heterogenous actors, notably in relation with community decisions as well as their connections with external stakeholders (e.g. governmental officials, unions, NGOs, business). Leaders can notably persuade peers to cooperate and enforce new norms if they mobilize social capital to try to define what are the collective interests of community members, (Wilshusen 2009; Ishihara and Pascual 2009).

Several other intermediaries are generally involved in PES design and implementation in order to coordinate the various interests expressed by users and providers of environmental services (Schomers et al. 2015; Landell-Mills and Porras 2002). Intermediaries can complement the lack of managerial, financial and technical skills of governmental officials and enable to translate PES requirements into grounded practices at community level (Landell-Mills and Porras 2002). Technical assistance is generally provided by third parties like NGOs, local governmental institutions or independent consultants. Technical assistants are in charge of fulfilling a range of functions, usually enabled by the institutional framework regulating the PES program or in response to the specific need in the context of implementation (Matzdorf, Sattler, and Engel

2013; Swallow et al. 2009; van Noordwijk et al. 2007). In some contexts, PES procedural rules contribute to create intermediaries' activities by explicitly defining their organizational characteristics, the rules shaping their functions and their prerogatives in order to reach the goals targeted by PES programs. In other contexts, intermediaries are organizations or individuals already active in forest management or conservation before the introduction of PES. In those cases, PES procedural rules regulate their activities and determine what should be the intervention strategies. Typical intermediaries functions encompass informing the potential beneficiaries about the goals of the program, negotiate transactions between forests managers and governmental agencies, training capacities of forest managers to fulfill conservation goals and also to monitor projects (Bosselmann and Lund 2013; Bennett et al. 2014; Huber-Stearns, Goldstein, and Duke 2013; Coggan et al. 2013).

Figure 1. A framework to understand PES effectiveness in collectively-owned forests



This dissertation tries to link processes induced by PES to its desired outcome (during PES implementation) and impact (beyond contract duration) (Figure 1). PES activities incentivized the realization of three processes: i) the selection of participants, based on rules of eligibility

and targeting criteria, mostly supervised by technical service providers, ii) the collective decision to participate, which rely on decision-making processes at community level but also persuasion by community leaders and iii) the implementation of new forest management activities, notably supervised by technical service providers and community leaders. However, PES effectiveness does not mechanically result from PES implementation. Instead, all the three processes require coordination and cooperation between actors located at different scales. This dissertation therefore considers that PES implementation and notably compliance to PES contract terms need that some actors mobilize social capital in order to allow the collective performance of agreed-upon rules of forest management. PES implementation is therefore affected by pre-existing institutions shaping collective action, and notably allows to build or to strengthen forest management institutions. Forest management institutions are affected by PES but there are many uncertainties regarding the ability of PES to support the maintenance of such institutions beyond contract duration. Chapter Three directly assess PES additionality, while Chapter Four explores how technical service providers contribute to mobilize social capital through the selection of participant and the technical assistance they provide. Chapter Five specifically considers the challenges related to the collective decision to participate and Chapter Six shows how difficult it is to mobilize social capital and build new forest management institutions.

The following section presents the research strategy used to operationalize this framework in this dissertation.

2.4 Research strategy: description of case study and methods

To operationalize the theoretical framework defined in the previous section, this dissertation relies on a case study approach. Case studies allow to comprehensively study real situations and enable researchers to explore extensively how certain things are done and why (Given 2008, 68–71). As such, findings form the case study cannot be straightforwardly generalized.

However, providing information on contextual factors eventually influencing the processes and outcomes of the studied phenomenon help to improve knowledge. A case study approach is not associated with particular research methods but the researcher has to justified how chosen methods are able to address the research objectives.

Congruent with the research framework defined in the previous section, the case study is based on an analysis at several scales (namely state level, sub-state regional level and community level). The next section describes the case study. Section 2.4.2 briefly describe the research methods and section 2.4.3 provides insights on ethics and reflexivity.

2.4.1 Evolution of PES programs in Mexico

The case study is based on the analysis of several governmental PES schemes in Mexico. I first provide elements about the governmental agency in charge of the implementation of these PES schemes before explaining the evolution and diversification of these schemes since their emergences. I also justify why Chiapas is an interested case study to assess the effectiveness of PES among forest owned collectively. I finally explain the collective tenure in Mexico and describe the regional and community levels of analysis used across the empirical chapters.

Mexico is among the world largest countries with 1'964'375 km2 and a population estimated at 118 million inhabitants. Mexico (officially *Estados Unidos Mexicanos*, the United Mexican States) is a federation of 31 States and a Federal district. It is a presidential republic ruled by a constitution enacted in 1917 in the aftermath of the Mexican Revolution started in 1910. Mexico is one of the twelve mega-biodiverse country, with a natural patrimony of global importance per the number of different species present on its territory. Mexico is notably characterized by very diverse forest ecosystems and an important proportion of forests under conservation schemes (FAO 2015). Mexico has lost about half of its forests over the last 50 years, but remains one of the most forested countries in the world (Barsimantov and Kendall 2012). The net

deforestation rate is nevertheless important (0,59% yearly in average between 1990 and 2010) but has started to decrease since the 2000's. However, the situation is very different across the regions, with highest rate in central and southern States. Especially, the State of Chiapas has contributed to around 12% of national deforestation between 1993 and 2007 (Soto-Pinto et al, 2012) while its area is only 3,7% of national area.

CONAFOR (Spanish acronym for *Comission Nacional Forestal*- National Forestry Commission) was created in 2001 by Presidential Decree (*Diario Oficial de la Federación*, April 4th 2001, pp37-42). CONAFOR is a governmental agency under the control of SEMARNAT (Secretariat of the Environment and Natural Resources). SEMARNAT is the Mexico's Ministry of Environment which is also the tutorial administrator of CONAFOR as well as CONANP (National Natural Protected Area Commission), CONAGUA (National Water Commission), INECC (National Ecology and Climate Change Institute), PROFEPA (Federal Attorney for Environmental Protection) and IMTA (Mexican Institute for Water Technology). The missions of CONAFOR are defined by the Sustainable Forestry Development Law (*Ley General de Desarrollo Forestal Sustentable*, LGDFS). The missions mostly consist with the implementation of forest policies and the development of national forestry sector, mainly through forest management programs but also forest conservation, including PES programs.

The first national PES scheme run by CONAFOR has been implemented since 2003. It has consisted in a PES program targeting forest ecosystems providing hydrological environmental services. It is generally known by its acronym PSAH (*Pagos por Servicios Ambientales Hidrológicos*). The scheme was initially funded by a fixed amount taken from an earmarked tax on water federally collected (Munoz-Pina et al., 2008). PES contracts have consisted in a five-year payment in exchange for avoiding land-use change on forests covered by a contract

(McAfee&Shapiro, 2010). A payment of 400 pesos/ hectare/year for cloud forests and of 300 pesos/hectare/year for other forests was proposed for eligible plots.

In 2004, CONAFOR developed a second PES program aimed at paying landowners for the provision of carbon sequestration services, biodiversity conservation or for the development of agroforestry systems (PSA-CABSA). After several reforms, both initiatives were merged into a broader forestry program initially known as ProArbol (Corbera, Soberanis, and Brown 2009; Shapiro-Garza 2013) but currently named PRONAFOR. The current PES program only provides incentives for two modalities of ecosystem services provision, namely hydrological services and biodiversity conservation. Despite its name, the program in its current form does not directly monitor the provision of these ecosystem services and it is focused exclusively on supporting the conservation of standing forests.

Since 2008, CONAFOR has the ability to develop special PES programs in specific areas. These programs can adapt the level of payment and the requisite to participate according to the environmental situation in the area. These programs are called matching funds, or outsourced local PES (*Fondos Concurentes*) and consist in PES implemented at a small scale. The principle is to create a fund where an organization (State, municipality, NGO) and CONAFOR put half of the money. The rules of operation of these programs are based on the rules of operation of national PES but the length of the contract is of 10 years instead of 5 years in the federal PES programs. Moreover, the organization that has put half of the budget can add its own requisite to the ones that CONAFOR asks. Several dozens of matching funds have been put in place all over Mexico.

Since 2010, CONAFOR has also sponsored “early” programs of Reducing Emissions from Deforestation and forest Degradation (REDD+) consisting of a portfolio of programs, favoring conservation, reforestation and sustainable management of forests, organizing around (but not limited to) PES programs, in some ecosystems considered of national importance, including the

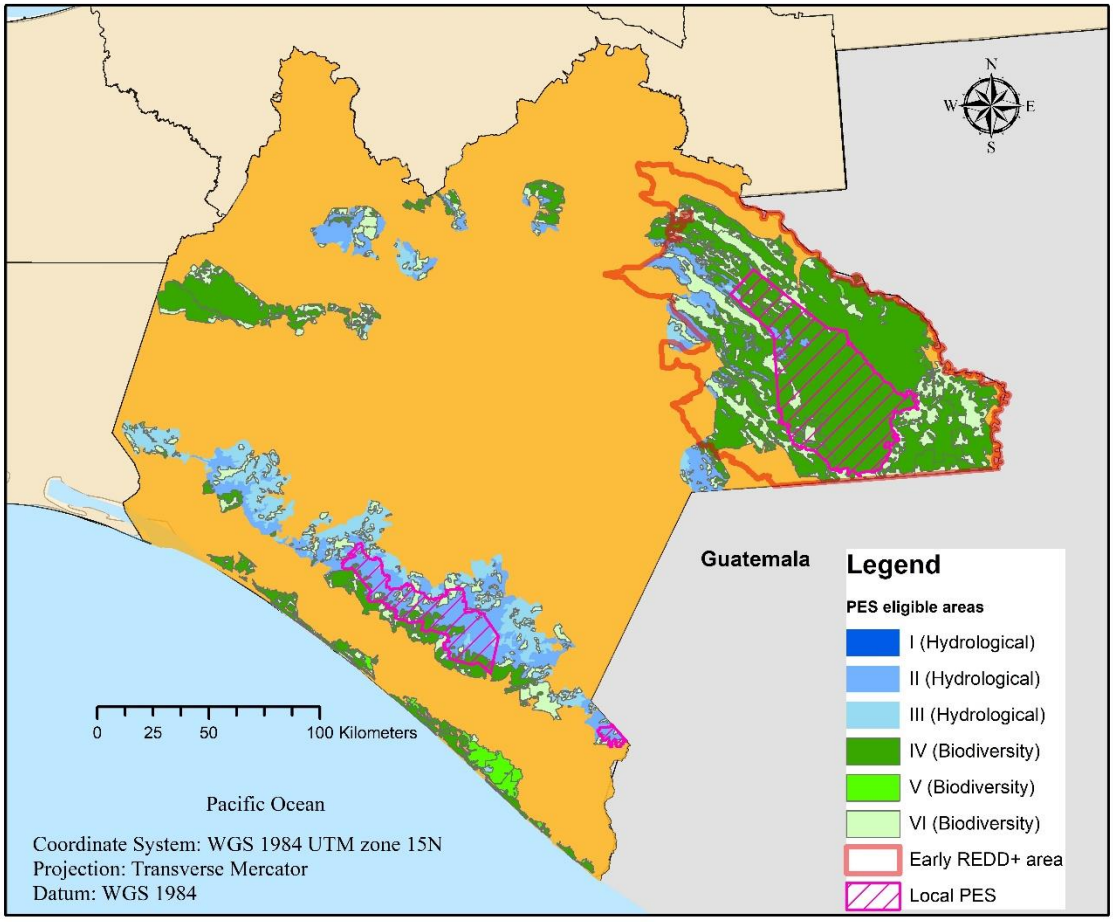
coastal watersheds of the state of Jalisco, the tropical rainforests of the peninsula of Yucatan and the biological corridors in the state of Chiapas. Within eligible areas, REDD+ programs substitute "standard" PES programs by proposing higher payment level while increasing requirements contained in the forest management plan. Since 2013, these requirements oblige participant communities to design a comprehensive community land-planning document (labelled as integral medium-term land development plan, *Programa Predial de Desarrollo Integral de Mediano Plazo*) expected to mainstream more effectively governmental forest regulations into community institutions. Note that this land-planning document is increasingly required as well in federal PES. Specifically, this plan requires a land planning exercise applied to all the forested areas of a participating community, which means that it is not limited to forests included in PES contracts. The design of this plan is in principle based on a participative diagnostic of the main productive activities existing in the community and try to propose solutions to limit the environmental damages created by these activities.

The State of Chiapas has contributed to around 12% of national deforestation between 1993 and 2007 (Soto-Pinto et al, 2012) while its area is only 3,7% of national area. It is therefore one of the State with highest rate of deforestation in the recent decades. At the same time, it is one of the poorest State of Mexico, with many municipalities among the more marginalized of the country. The state of Chiapas is also the hosts of numerous protected areas and has been considerably represented in terms of number of PES contracts. The state of Chiapas hosts a significant proportion of PES contracts, targeted at individual landowners, rural *ejidos* and indigenous communities.

All of the different PES modalities previously described have been implemented in various places of Chiapas (see Figure 2). As the Chapter Four is based on data collected among many of the TSP active in the State of Chiapas, all of these modalities are explored in this chapter. The analysis in Chapter Three is limited to the federal PES focused on biodiversity

conservation, as the chapter relies on data from 2008 and 2009 when the studied area was only eligible to this PES modality. Chapter Five and Six analyze a community who has simultaneously received both a federal PES focused on biodiversity and early REDD+ program.

Figure 2. PES eligible areas in Chiapas (2013)



Note. This map has been produced using information published online by CONAFOR in 2013. Eligible areas might change from one year to another. Each eligible area is associated with specific payment level and required activities. Not all forest included in eligible areas effectively receive PES payments.

The different PES modalities differs in terms of eligible areas, payment level and contract duration but their underlying forest conservation objectives have remained the same. The targeted areas and enrolled landowners are identified through a set of eligibility and selection criteria published in the annual operational rules, as the budget is not sufficient to cover all applicants (Sims et al. 2014). To receive a PES contract, applicants have to formulate an

application proposal, eventually with the help of a technical service provider. If the proposal is accepted by CONAFOR, the participant has to submit a forest conservation plan in exchange of a 5-year annual payment.

Privately and community owned lands can be included in PES contracts. In the case of *ejidos*, the decision to participate is a collective choice decided by the ejido assembly, which is the most important decision-making body made up of all right holders. The parcels included in program funding applications can involve all or a portion of or the community's commonly managed forests, or selected forested parcels controlled by households. Applicants can hire technical service providers to develop their application proposal and payment-targeted parcels are geo-referenced as polygons. Once an application is approved by CONAFOR, the proponent(s) must design a forest management plan on the contracted polygons, which is also developed with service providers' support. It is important to note that the funds are limited, so CONAFOR has to select only the best projects. This means that a considerable number of projects which fulfil all the eligibility criteria does not receive payment because they are not in the top of projects according to the score they receive. However, goods projects that does not receive funds can receive extra points if they present a new project the following year.

Because the procedural rules are complex, technical service providers, generally independent consultants or conservation NGOs, are in charge of explaining PES principles and helping the communities to write down the application. Technical assistance was traditionally a state prerogative but the neoliberal reforms of the 1990s have progressively reinforced the role of private consultants in the design and implementation of all activities related to forest management (Klooster and Masera 2000; Bray, Antinori, and Torres-Rojo 2006). The procedural rules of PES did not initially explicitly require contracting technical service providers but their involvement is critical to select participants, implement PES activities and monitor progress (Ezzine-de-Blas et al. 2016). The technical assistance is generally performed

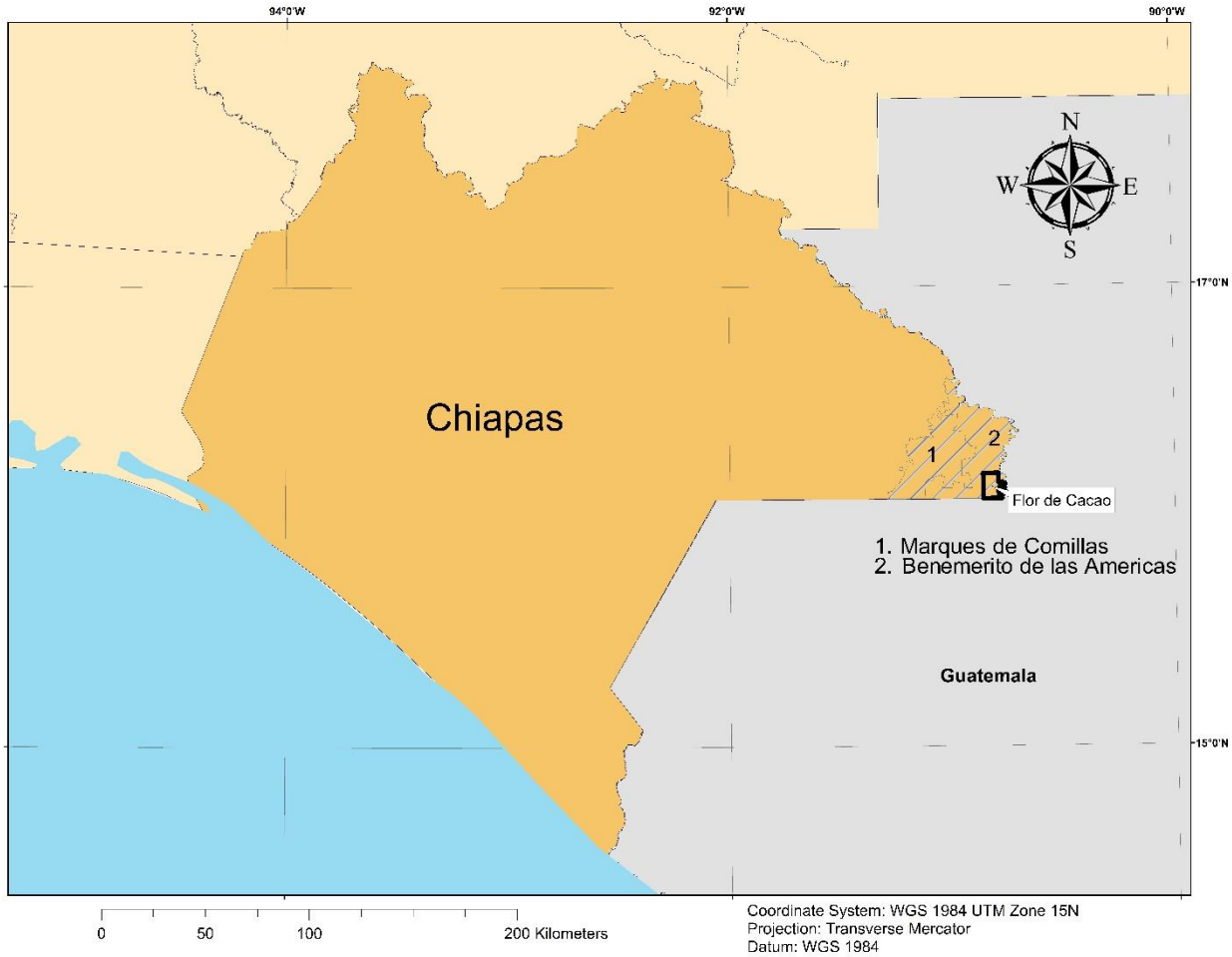
by independent service providers. These services providers intervene in the process at two different phases. First of all, they are the intermediaries who help communities to elaborate a proposal that will be submitted to CONAFOR to eventually receive payment. CONAFOR does not provide support for this preliminary activity, so the service provider and the potential participants have to reach their own agreement on the cost of this service, especially because there is no guarantee that the proposal will be accepted and funded by CONAFOR. In the case that the project is accepted, the service providers receive a payment for technical assistance. This payment is also an annual payment of five years, conditioned to the fact that the beneficiary respect the conditions formulated by CONAFOR. The service providers have to help the community to formulate their PES forest management plan the first year. CONAFOR gives a list of mandatory activities and optional ones that the service providers have to incorporate in the forest management plan. Each year, the service provider has to monitor that the activities have been implemented correctly. The provider have to send a report to CONAFOR which check if participants respect the conditions of the contract.

Since 2008, technical intermediaries have to be accredited by CONAFOR in order to ensure that they have the sufficient knowledge on the program to be able to participate. Since 2012, the accreditation process has been changed into a certification. Service providers have to demonstrated that they have the needed experience to help the beneficiaries. They have to show evidence on their understanding of rules of operations and their ability to provide the expected technical assistance.

The source of information on PES programs comes from three major sources which are in first place the rules of operations and technical documents published by CONAFOR to analyze the evolution of procedural rules. These documents provide information about the activities and the way programs should be implemented. CONAFOR also publishes evaluation reports, eventualy carried out with the help of external consultants or academics. Evaluation reports

provide information on the results of the program and the perceptions of beneficiaries. These reports can describe some weaknesses of program and question their relevance. Finally, academic literature provides information about the evolution of PES programs (Alix-Garcia et al. 2005; McAfee and Shapiro 2010; Muñoz-Piña et al. 2008; Sims et al. 2014; Ezzine-de-Blas et al. 2016), and empirical case studies illustrating the challenges associated with PES participation and implementation (Corbera, Soberanis, and Brown 2009; Kosoy, Corbera, and Brown 2008; Balderas Torres et al. 2013; Méndez-López et al. 2015) and assessments of their environmental effectiveness (Honey-Rosés, Baylis, and Ramirez 2011; Alix-Garcia, Shapiro, and Sims 2012; Alix-Garcia, Sims, and Yañez-Pagans 2015) or other inuntended outcomes such as motivations crowding-out (Rico García-Amado, Ruiz Pérez, and Barrasa García 2013).

Figure 3. Analytical scales of the case study



Note. The case study is composed of three analytical scales: (i) state, ii) region composed of the municipalities of Marques de Comillas and Benemerito de las Americas and iii) the *ejido* of Flor de Cacao.

2.4.2 The analytical scales

The case study is composed of three analytical scales (Figure 3). Chapters Three, Four and Five are based on data collected in the municipalities at the south of the Lacandon Rainforest. Note that in this dissertation, the word municipality (*municipio* in Spanish) only refers to the geographical space covered by the administrative boundaries, and not to the specific sub-state level of government endowed with certain prerogatives regarding the delivery of some public services.

In the 1970's, the area covered by the two considered municipalities held large tracts of rainforest but as of today less than half of the original cover remains today. Over this period, these municipalities have had one of the highest deforestation rates in the country (Soto-Pinto, A., and Jimnez-Ferrer 2012). Most forest loss in the past was driven by government settlement policies, which brought large numbers of landless farmers from around the country to Chiapas between 1970 and the early 1990s (Carabias, Meli, and Hernández 2012). Present threats to forests are linked to agricultural and pasture expansion (Soto-Pinto, A., and Jimnez-Ferrer 2012), which are activities that are encouraged by government programs, in addition to a flat topography (Carabias, Meli, and Hernández 2012). Livestock raising has been the main livelihood activity until this last decade, when new productive activities promoted by private actors, such as African oil palm cultivation -now grown in 26 of the 37 *ejidos*-, have gained prominence (Soto-Pinto, A., and Jimnez-Ferrer 2012; Carabias, Meli, and Hernández 2012). Both governmental and non-governmental conservation policies and projects began to be implemented during the 1990s, focused on controlling slash and burn agriculture, and illegal timber logging. However, limited funding, monitoring and enforcement by both state and federal governments, have contributed to their limited success.

PES programs have recently emerged in the two selected municipalities as a complementary conservation incentive in a context of increasing tensions between land-use change and a growing number of conservation initiatives. For example, the two selected municipalities are located within a biological corridor established in 2007 to connect various Biosphere reserves in the southern part of Mexico (Carabias et al. 2009; Carabias, Meli, and Hernández 2012), and in addition to other areas located in the states of Jalisco and of the Yucatán peninsula, they belong to one of the three key target early action areas for Reducing Emissions from Deforestation, forest Degradation and enhancing carbon stocks (REDD+) . In Chiapas, early actions are structured around the Special Program for the Lacandon rainforest (*Programa Especial de la Selva Lacandona* or PESL, for its Spanish acronym), which is implemented in eight municipalities that still have standing rainforest. This special program includes a PES mechanism specifically designed to address local drivers of deforestation and forest degradation, among other incentives for sustainable use and rainforest conservation.

In the selected municipalities, the first PES contract was signed in 2005 but the program gained momentum in 2008, when seven *ejidos* were granted a contract for biodiversity payments. As noted, 19 *ejidos* are now involved in the program. The remaining 18 *ejido*s have declined or have been unable to participate and, among these, there are four *ejido*s lacking administrative pre-requisites to become PES eligible. According to CONAFOR officials, others do not participate because they do not own sufficient primary forest or their forests have already been divided among too many families and converted into other land uses. The rest have simply refused to participate because they are not interested or do not have the ability to make a collective decision in this regard. As the program is voluntary, forest owners can decide not to participate in the program regardless of the level of forest cover found in their properties.

Chapter Five and Six specifically study the *ejido* of Flore de Cacao (FdC). In Mexico, between 60 and 70 per cent of the country's forests are collectively owned (FAO, 2010; Madrid et al.,

2009). Collective property embraces several types of arrangements, namely indigenous communities, agrarian communities and *ejidos,* each type having specific customary and organizational characteristics (Bray et al., 2003; Skutsch et al., 2014). Property rights are defined by the article 27 of the Mexican Constitution (*Constitución Política de los Estados Unidos Mexicanos*): while the right for collective rightholders to organize themselves as they desire is recognized, the regulative power of the government over natural resources is emphasized.

In *ejidos*, a group of rightholders called *ejidatarios* are collectively granted with a property title over a piece of land. The formal functioning of *eijidos* is currently specified by the Agrarian Law (*Ley Agraria*) promulgated in 1992, in accordance with the Article 27 of the Constitution (Hausermann, 2014; Kosoy et al., 2008). All *ejidatarios* are members of the community assembly, which is the highest decision-making body where community rules are approved and negotiated during regular (usually monthly or bi-monthly) meetings. The assembly is also in charge of electing every three years the legal representative of the *ejido* (known as *comisariado*), who is responsible of the administrative management of the community and the enforcement of community decisions. Within an *ejido,* land can be divided either in individual or collective plots but *ejidos* generally include a combination of both (Hausermann, 2014; Kosoy et al., 2008). These individual and collective plots can be accessed by non-rightholding community members, known as *avecindados* or *pobladores* through borrowing or renting from *ejidatarios,* on the conditions decided by the community assembly. The Agrarian Law recognizes all forests within *ejidos* as collectively owned, but some communities have internally agreed to divide their forests into individual plots.

Flor de Cacao is an *ejido* located in the municipality of *Benemérito de las Americas* in the southeast of the state of Chiapas, bordering Guatemala. Before the 1970s, this region was mainly covered by rainforests owned by the federal government (Soto-Pinto, Castillo-Santiago,

and Jiménez-Ferrer 2012). *Flor de Cacao* was formally established in 1984 by a group of *Tseltal* indigenous migrant families who came from other parts of the state and who settled incentivized by the government's colonization policies (de Vos 2002). Nearly 10,000 hectares of land were granted by presidential decree and around 50 hectares were granted to each of the 184 settling families.

Although the majority of land is officially considered by the government as being under collective tenure (SRA 2011), there is nowadays no land or forest managed in commons. Most of forests are located outside the village while agricultural land is concentrated near the river constituting the eastern boundary of the *ejido.* The main economic activity of households is related to agricultural production of corn, beans and chili, cultivated for self-subsistence and sold to regional markets (SRA 2011). Few *ejidatarios* are also involved in livestock production, oil palm and rubber tree plantation and others are local taxi drivers or small-business owners while non-*ejidatario* households are generally hired as agricultural workers. Because population density has remained quite low (0.15 hab/ha), large parts of the *ejido* have not yet been turned into agricultural crops or pasture. In 2011, previously non-managed forests have been split into 20 ha parcels and distributed between *ejidatarios* during a land titling program called FANAR.[2]

Visual interpretation of remote sensing data map allows to conclude that significant land use changes have occurred between 1996 and 2005 (Soto-Pinto, Castillo-Santiago, and Jiménez-Ferrer 2012) but that some forests have still been cleared between 2007 and 2013 (Costedoat et al. 2015). Around a third of *ejidatarios* do not currently have forest parcels because they have deforested it or sold it to other *ejidatarios*. After the end of FANAR, the total number of

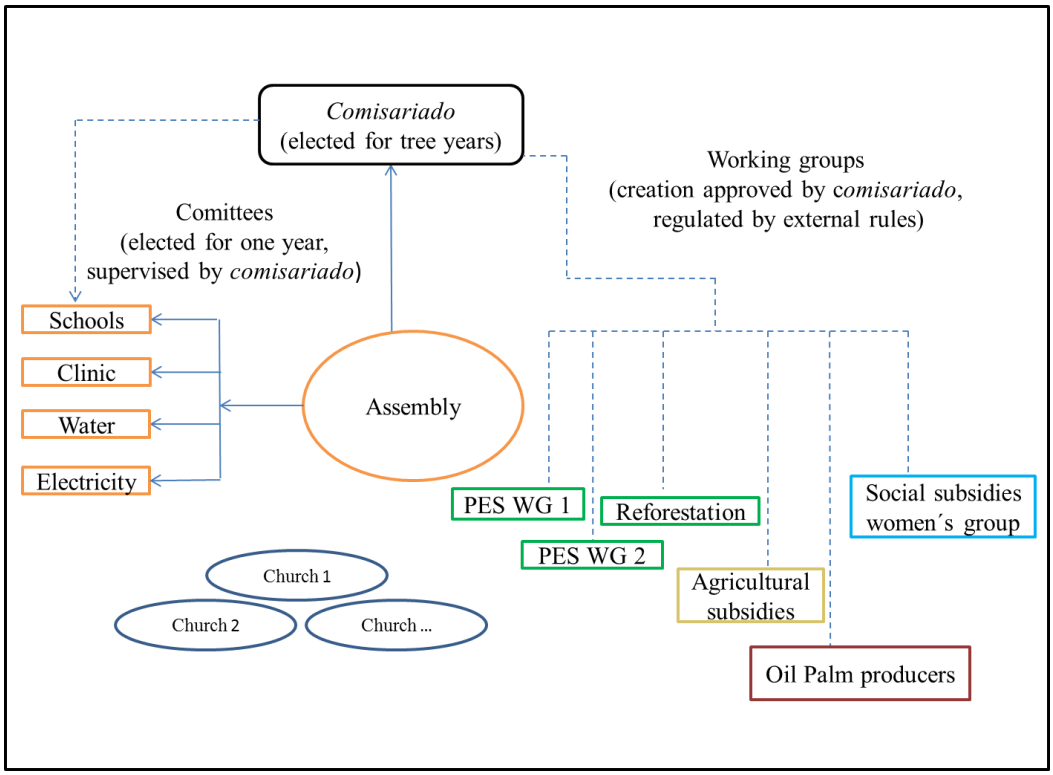
[2] FANAR is the Spanish acronym of a voluntary governmental program dedicated to delimit parcels, certify property rights and organize the internal functioning of *ejidos* (Procuraduría Agraria 2008). It is an extension of PROCEDE program, active between 1993 and 2006 (Hausermann 2014; Kosoy, Corbera, and Brown 2008).

ejidatarios has reached 308 (approximately ten percent of them are female), with the integration of some adult children from original *ejidatarios* and settlers who bought land after the creation of the *ejido*.

The considerable number of *ejidatarios* has favored the emergence of committees, which are decentralized structures subordinated to the assembly. Currently constituted committees are used to manage schools, the clinic, the water delivery system and to collect fees from electricity bill, i.e. to facilitate the coordination between the community and respective governmental services (Figure 4). The community assembly and the committees have been the main promoters of occasional or regular collective activities through mandatory (but egalitarian) contribution in money or in work time, e.g. renovating school buildings or removing trash in village streets and around the river.[3]

Figure 4. Social organization in Flor de Cacao

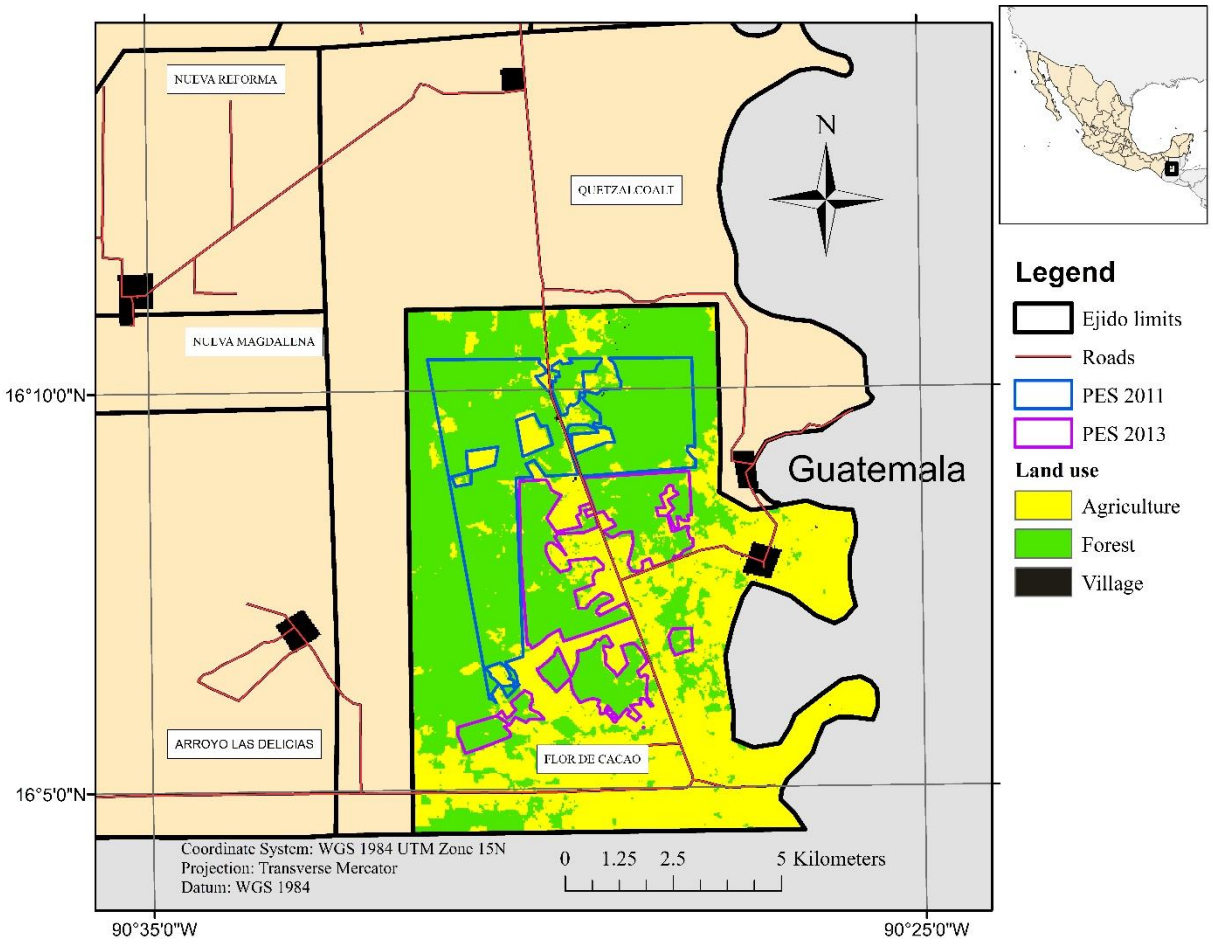
[3] Churches (seven christian faiths gathering roughly half of community members are represented in the community) also require some punctual contribution and activities to their followers.



Note: Collective action in FdC is promoted by different bodies. Collective action in activities of general interests is usually supervised by the *comisariado*, while particular interests are managed through working groups and to a lesser extend churches.

Working groups are another form of organization consisting in voluntary associations of individuals aiming at participating in a governmental program or a productive project without transiting by the assembly (Wilshusen 2009). In FdC, most of the existing working groups are informal organizations related to the implementation of conditional cash transfer governmental programs (currently two working groups involved in PES, reforestation, agricultural and women's social programs), the only exception being the formal constitution of a small group of producers involved in oil palm, in accordance with federal regulation and specific characteristics of the production (Rico García-Amado et al. 2012).

Figure 5. PES contracts in Flor de Cacao, Chiapas



Note. Map elaborated with data described in Costedoat et al. (2015). PES polygons are given as indicative and correspond to forest areas located outside the village.

A group of *ejidatarios* entered the PES programme in 2011 with around 1820 hectares. In 2013, an additional forest area was placed under PES by another group, to amount a total of 2450 hectares (Figure 5). The first villagers to join the PES programme in 2011 were a group of 60 *ejidatarios* who held secure land titles. This first group was keen to get involved in the PES programme, while other *ejidatarios* mistrusted the programme because they thought that it would lead to the expropriation of their agricultural and forest lands by the government. Therefore, this first group of *ejidatarios* constituted a working group (*grupo de trabajo*) and got the permission of the assembly to apply and get involved in the programme, since the 1820 hectares of forested lands to be targeted were exclusively located on the applicants' own plots. The working group, in turn, elected leaders entitled to collect PES money and perform

administrative actions on behalf of group members. The group as a moral person signed the contract with CONAFOR but each member had to demonstrate they formally owned the forests targeted by the contract. Monetary compensation was granted on an individual basis and in proportion to the area included in the programme through a flat payment by hectare (550 MXN per hectare). In 2011, CONAFOR allowed them to reclassify their PES contract in the REDD+ Special PES programme to raise the payment level (an additional 450 MXN per hectare) while also increasing the forest management plan requirements.

In 2013, a second group of 90 people joined the REDD+ Special PES programme through an additional collective contract covering 630 hectares of forests. The group involved landowners with formal property rights who did not trust, ignored or were not aware of the first group's application, and household heads who lacked formal property titles in 2011 but had acquired such titles a year after. In this second group, *ejidatarios* who were not members of the first group could choose to pool their forest parcels under the collective contract. In this second group, group leaders agreed to re-distribute the payment between group members to increase the minimum amount of money that small landowners could receive every year, i.e. larger landowners would receive less money than if they had joined the first group. Another particularity of this second group was related to recent changes in the federal programme's operational rules: 40% of the annual collective payment had to be re-allocated to forest conservation activities defined in the forest management plan.

In *Flor de Cacao*, there are still some villagers who do not belong to any of these two groups. There are formal landowners with forested land plots who are not involved in the programme because they did not have time to register to any of the existing groups, are still afraid of getting their lands expropriated or are just not interested in the programme's objectives, particularly if they are involved in deforestation activities. Other villagers are unable to participate because they do not have property titles or standing forest parcels.

2.4.3 Research methods

This dissertation is based on various research methods, both qualitative and quantitative. As each empirical chapter is based on methods, more details are provided at the beginning of respective chapters. Chapter Three is based on a quasi-experimental impact evaluation framework. Such framework is expected to help researchers to credibly measure the effectiveness of a program by comparing the performance of some units receiving a program with units not included in the program but used as counterfactual.

Chapter Four relies on semi-structured interviews. Semi-structures interviews are based on open-ended questions that are not limited to specific types of answers. Questions are based on an interview guide but the researcher can modulate the order of questions and the details collected in function of the information provided by the interviewee (Given 2008, 810–11).

Chapter Five develops a Choice Experiment (CE) questionnaire. Choice Experiment allows eliciting people's interests and values as stated in choice situations (Louviere, Hensher, and Swait 2000). Choice experiment consists in asking an interviewee about her/hies preferences between different hypothetical situations. Each situation is characterized by a number of themes (or "attributes" in CE terminology), which describe the content of the proposed contract. Each contract is then composed of specific values for each theme. These values ("levels" in CE terminology) are categories defined by the researcher and represent possible variations of characteristics around the same theme. The experiment generally consists in making the respondent state the preferred combination of attributes and levels among various combinations presented. Each hypothetical situation can include, among other characteristics, a unique value corresponding to a proposed monetary compensation. After the data have been collected, statistical choice models are used to analyze responses so that the researcher can determine which are the levels preferred by the respondents and eventually express them in monetary terms.

Chapter Six is based on focus groups, participant observation and semi-structured interviews. Focus groups is a method of data collection obtained through a discussion between several selected individuals. Focus groups analyze how several discutants may agree or disagree in their opinions related to a specific topic (Given 2008, 352–54). The participants are chosen by considering that they have certain characteristics in commons, and these characteristics are especially relevant for the research topic. The researcher can act as a moderator in order to collect a variety of opinions about the questions asked but also guaranteeing to each participant the right to express herself/himself. Participant observation is an immersion in the daily life of individuals or groups during long period of times, e.g. weeks or months. Such technique help the researcher to better understand contextual characteristics relevant to explain the research topic. The researcher is able to interact with individuals and groups on a daily basis, and eventually allow more detailed understanding about the beliefs of the studied individuals.

2.4.4 Considerations on reflexivity and ethics

This dissertation has been a personal challenge at various levels. When I started my PhD, the INVALUABLE project was already running for nine months. Belonging to such international project helped me to easily organized the first steps of my dissertation in order to follow the goals of the project. As two of my supervisors acted as Work Package coordinators, I have always been aware of the general advancements of the project and have been invited to participate to several international conferences and workshops organizes by project members. I therefore think that I have always been in a privileged position, allowing me to exchange with several authors researchers while organizing my research activities.

Nevertheless, the first objectives at the beginning of my dissertation has been to design a methodology able to measure PES effectiveness in rural communities (Chapter Three) while starting to write the theoretical foundations of my dissertation. Overall, I have spent nearly two years focused mostly on the challenges associated with the quantitative measurement of

additionality, at the expense of the conceptual reflection about institutions and collective action that mostly occurred in the last three years of my dissertation. Even if the steps necessary to finish my first two publications using quantitative methods have been arduous, I recognize that I have been considerably more comfortable using these types of methods, as compared with qualitative methods. Indeed, learning to collect and analyze qualitative data, but also mobilizing qualitative concepts has been a very complicated task for me. I had to learn how to think differently, and structure my research in a totally different way to what I initially planned. Interestingly, while in my fist years of dissertation, I mostly needed the support of my supervisors regarding the formal aspects of scientific writing, their support regarding the content of my research itself has been critical in the last years. However, I have struggled a lot to gain maturity and be able to plan my research according to a precise calendar in order to facilitate collaboration with my various supervisors and co-authors. While I enjoy working in autonomy and explore literature by myself, I am aware that my work rhythm and my insufficient communication has complicated my research activities.

Beyond the purely academic achievement, this dissertation has also required a substantial logistical organization, as I have spent nearly one year in fieldwork in Chiapas, Mexico. Thanks again to my supervisors, I have been able to work in collaboration with ECOSUR, in the city of San Cristóbal de las Casas, Chiapas, Mexico. ECOSUR is a leading research university dedicated to environmental and social research in various southern Mexican states. Based in ECOSUR, I have been able to develop many contacts with academics, CONAFOR officials, technical service providers and community members. I therefore enjoy a nearly complete independence in choosing my case studies and levels of analysis. In particular, I have been able to explore the diversity of social, environmental and institutional diversity not only of Chiapas but of Mexico in general through numerous interviews with key informants.

While organizing interviews with policy makers, scholars and technicians has been relatively easy, contacting communities has been more complicated. Indeed, I had decided to work in communities not studied by other researchers but also not supervised by conservation NGOs (see Chapter Four). However, communities fulfilling these criteria generally correspond to communities less used to interact with strangers, notably in the case of a foreign PhD student. One community notably refused to accept my presence, arguing that if I do not bring monetary resources to them, they have no interest in "loosing time with me". Nevertheless, in other communities, the fact of being introduced by a technical service provider and to be able to explain my research project to community leaders has been sufficient to persuade communities to welcome me. I initially wanted to perform the analysis carried out in Chapters Five and Six in two or more communities, but I had to limit to only one community due to the duration of the fieldwork.

In Flor de Cacao, the fact that the community elected representative has been very enthusiastic about my research has been considerably helpful. While I have tried to explain my research to the assembly of rightholders, it is the community representative that effectively persuaded the assembly to accept my presence. Some community members considered my presence as suspicious, arguing that I could be paid by the Mexican government to spy them, or that I can be working on behalf of foreign corporations to evaluate the natural resources owned by the community. My personal involvement in the daily activities of community members has contributed to improve trust and facilitated data collection. Many community members have been very surprised to see a foreigner helping to sow maize, to harvest beans and to clean firebreaks but also ridding horses, speaking some words of Tzeltal and even just staying in the community!

I was surprised that nearly no community members expressed interests in hearing some results from my research, notably when I tried to deliver preliminary results from the analysis carried

out in Chapter Five. Instead, I quickly realized that most community members were fascinated every time I talked about life conditions in the rural areas of France. As I grew up in a farm, my basic knowledge of French agriculture and forestry has been very helpful to create contact with community members! I have in particular developed very good relations with professors from secondary school, and I have been invited several times to discuss with the pupils of the community.

Overall, data collection has been much complicated than anticipated. Many community members initially refused to talk to me, because they were shy or did not trust me. Organizing interviews has also been challenging because every male community members used to work in his plot outside the community from 6AM to 3PM, and therefore do not want to be interviewed at this moment. After work, these same individuals generally argued that they are too tired to answer my questions. I therefore generally invited myself to most social gathering in order to interact directly with groups of community members and clarify the purpose of my presence. As I always wanted to understand the diversity of points of views, I have alternatively spent time with several subgroups I have identified. Nevertheless, I have not been able to talk extensively with some community groups such as indigenous women and some community members without property titles. Actually, most of the female I have talked too have lived several years outside the community in urban areas of Mexico or United States.

3. The environmental additionality of PES contracts[4]

This chapter analyses the environmental effectiveness of PES programs in a region of the state of Chiapas, Mexico where numerous PES contracts have been implemented. In doing so, it addresses the first research question: "*Do PES programs cause additional conservation outcomes?"*. The contribution of this chapter is to propose an empirical strategy able to measure PES effectiveness when these programs are implemented in forests collectively-owned.

This chapter uses a quasi-experimental counterfactual approach based on matching techniques and a difference-in-difference estimator to assess the environmental effectiveness of PES programs. The analysis measures the extent to which deforestation has been avoided among 13 communities with PES contracts between 2008 and 2013. Results shows that the forests additionally conserved by PES represents an equivalent of around 14.3% of the area included in PES programs, as compared to control areas. This figure is considerably high in comparison with other studies of PES effectiveness, but can be explained by the important deforestation trends of the study area. Nevertheless, results also demonstrate that deforestation also occurs in forests covered by PES contracts, which suggests that PES are not necessarily associated with strict environmental compliance.

Section 3.1 presents the empirical strategy proposed to measure the environmental effectiveness of PES programs when these programs are implemented in collectively-owned forests. Section 3.2 highlights the main results. Section 3.3 discusses the results considering the emergent evidence on PES effectiveness as well as the challenges related to measuring effectiveness in collectively-owned forests.

3.1 Measuring the environmental effectiveness of PES

[4] This chapter is adapted from (Costedoat et al. 2015) and from Chervier and Costedoat (2017).

Measuring the environmental effectiveness of PES is not straightforward. Simply measuring the difference between the stock of forest conserved at the end of the contract with the stock of forest conserved at the beginning of the contract is likely to not accurately measure the effectiveness of PES programs. Indeed, this procedure does not allow to disentangle the performance of PES from other contextual characteristics also likely to influence conservation outcomes. In what follows, I introduce a quasi-experimental framework able to accurately measure PES-related outcomes. Section 4.1.2 describes the studied area. Section 4.1.3 defines the unit of analysis and describes the sources of data. Finally, the last subsection presents the estimation procedure.

3.1.1 A quasi-experimental framework to assess PES effectiveness

The environmental additionality of PES programs is not easily measurable because the reference baseline (what would have happened in the absence of PES program) is hypothetical and thus not observable. Nevertheless, Rubin's potential outcome framework considers that it is possible to estimate the Average Treatment Effect (ATE) by using the outcome of a group of non-treated units as a counterfactual for the outcome of a group of treated units (Holland 1986; Imbens and Wooldridge 2009). Credibly measuring the treatment effect then requires to carefully determine if non-treated units constitute plausible counterfactuals. Experimental approaches, such as Randomized Control Trials, could potentially contribute to measure the environmental additionality of PES programs but participants to PES programs are generally selected using targeting and administrative criteria defined by policy-makers. Therefore, participant and nonparticipants may exhibit different observable but also unobservable characteristics that can influence conservation outcomes, independently of the participation or not in PES programs. However, recent development of quasi-experimental methods in environmental sciences allows researchers to define counterfactuals based on empirical data (Greenstone and Gayer 2009; Blackman 2013; Miteva, Pattanayak, and Ferraro 2012).

Counterfactuals are defined from a selection of control units more likely to represent the outcomes that would have followed treated units in the absence of PES programs.

Among the different quasi-experimental methods, matching methods consist in associating one or several non-treated units to each treated unit based on observable characteristics. Matching aims at defining pairs of similar units, but it is often impossible to find two exactly similar units. Among the several existing matching metrics, the propensity score and the Mahalanobis distance are the more common approaches characterizing similarity in the literature (Imbens and Wooldridge 2009). The propensity score is based on the calculus of the probability of receiving the treatment as a function of observable characteristics likely to explain participation. The principle of propensity score matching is to compare the evolution of outcomes of treated units with the evolution of outcomes of non-treated units which have a high probability to enter the program. The Mahalanobis distance, in contast, associates each treated unit with its "nearest neighbor(s)" according to a standardized value of the chosen observable characteristics. While there is still lack of evidence about the superiority of one matching metric over the other, the Mahalanobis distance is generally preferred because it is assumed that this matching metric is associated with better performance and requires less restrictive hypotheses regarding the modeling of similarity (Zhao 2004; Imbens and Wooldridge 2009). Matching methods are nevertheless not always sufficient to obtained a credible measure of the Average Treatment Effect of a program. Instead, matching is often used to pre-process data in order to obtain a balanced sample with sufficient overlap in the distribution of observable characteristics between treated and non-treated units (Ho et al. 2007; Imbens and Wooldridge 2009).

Once a balanced matched sample is defined, a difference-in-difference (DID) estimator can replicate a natural experiment in which one can compare the outcome of treated and non-treated unit groups over at least two periods, i.e. before and after the implementation of the treatment (Pattanayak, Wunder, and Ferraro 2010; Imbens and Wooldridge 2009; Greenstone and Gayer

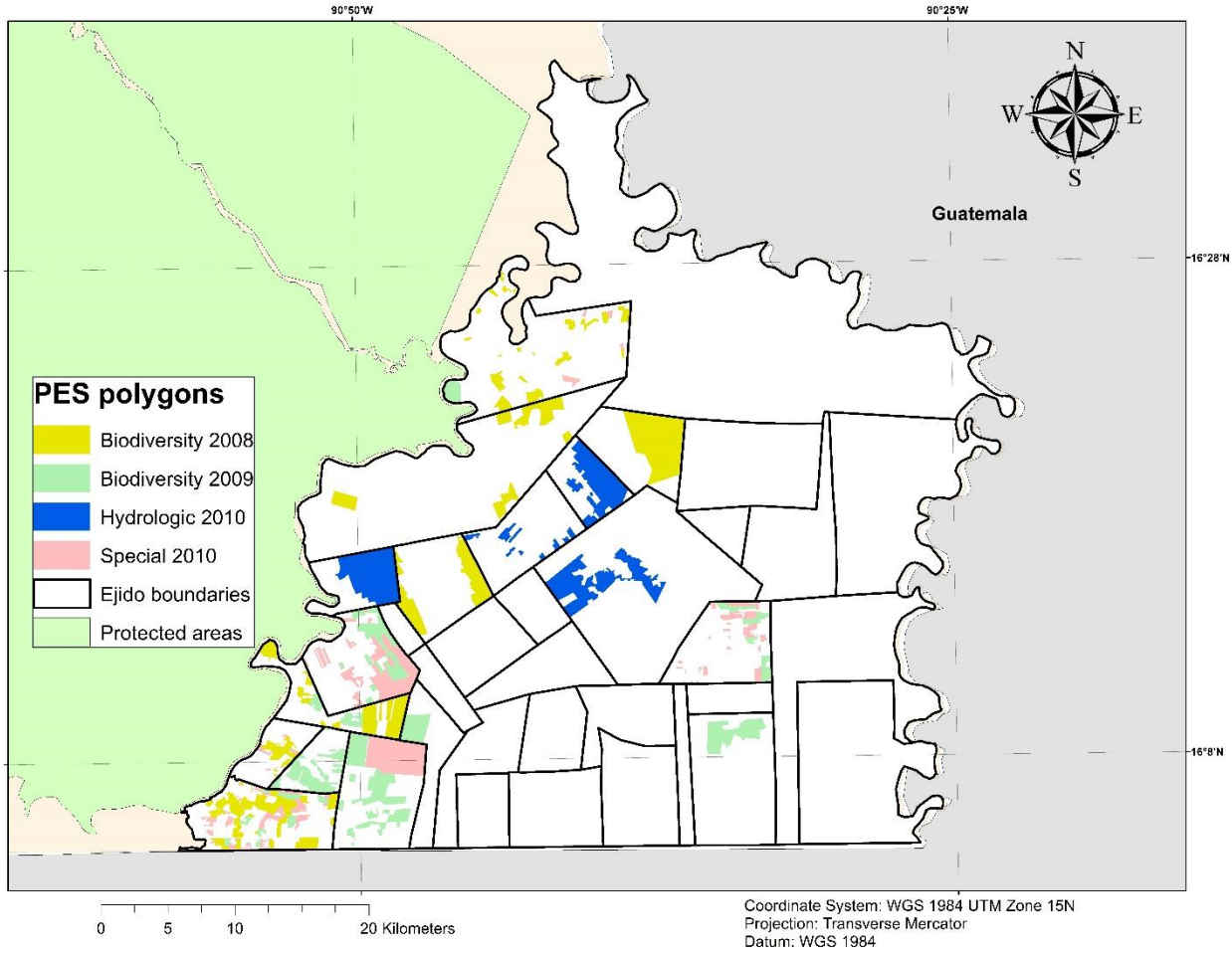
2009). The non-treated group is used as a control, and the outcome gains of the non-treated can be subtracted from the gains of the treated. The advantage of this method is that it removes the bias from permanent differences between the two groups as well as it neutralizes common time trends that are not related with the treatment (Imbens and Wooldridge 2009). However, even with precise identification strategies, there is a risk of missing important factors – and particular unobservable characteristics- associated with the selection into treatment group or determining program outcomes (Imbens and Wooldridge 2009).

To limit the influence of non-observable factors, this analysis examines program implementation in a geographically limited area where communities have relatively similar historical trends, land use patterns, and potentially similar access to information and to road infrastructures. Therefore, this analysis relies on the (untested) assumption of unconfoundedness, i.e. that no unobserved characteristics are associated with treatment or program outcomes, or at least that all unobserved characteristics are caught by observable variables used in the matching specifications.

3.1.2 Study area

The study area encompasses the municipalities of *Marqués de Comillas* and *Benemérito de las Américas*, which include 23 and 14 *ejidos*, respectively (Figure 6). Over this period, these municipalities have had one of the highest deforestation rates in the country (Soto-Pinto, Castillo-Santiago, and Jiménez-Ferrer 2012). Most forest loss in the past was driven by government settlement policies, which brought large numbers of landless farmers from around the country to Chiapas between 1970 and the early 1990s (Carabias, Meli, and Hernández 2012). Present threats to forests are linked to agricultural and pasture expansion, which are activities that are encouraged by government programs, in addition to a flat topography favorable to extensive practices.

Figure 6. PES polygons (2008-2010) in the studied area



Note. Each parcel under PES contract is geo-referenced by technical service providers. This map includes the polygons that were included in PES between 2008 and 2010 in the study area. It does not display PES polygons corresponding to past or future PES contracts. This map is my own elaboration using data from CONAFOR (PES polygons), CONABIO (protected areas polygons), INEGI (municipal and international boundaries). *Ejido* boundaries have been elaborated by the author, taking into account administrative and academic sources and may be imprecise in the case of *ejidos* that have not formally engaged in a land-titling program.

In the selected municipalities, the first PES contract was signed in 2005 by a single *ejido* but the program gained momentum in 2008 and 2009, when seven *ejidos* were granted a contract for biodiversity payments (Figure 5). This popularity can be explained by an increasing governmental budget for PES programs at that time but also by an active targeting and dissemination strategy focused in municipalities bordering the Lacandona rainforest. A total of 19 *ejidos* have been involved in Pthe ES program and so far, all of them have been successful in renewing their contracts. The remaining 18 *ejidos* have declined or have been unable to

participate and, among these, there are four *ejidos* lacking administrative pre-requisites to become eligible. According to CONAFOR officials, others do not participate because they do not own sufficient primary forest or their forests have already been divided among too many families and converted into other land uses. The rest have simply refused to participate because they are not interested or do not have the ability to make a collective decision in this regard.

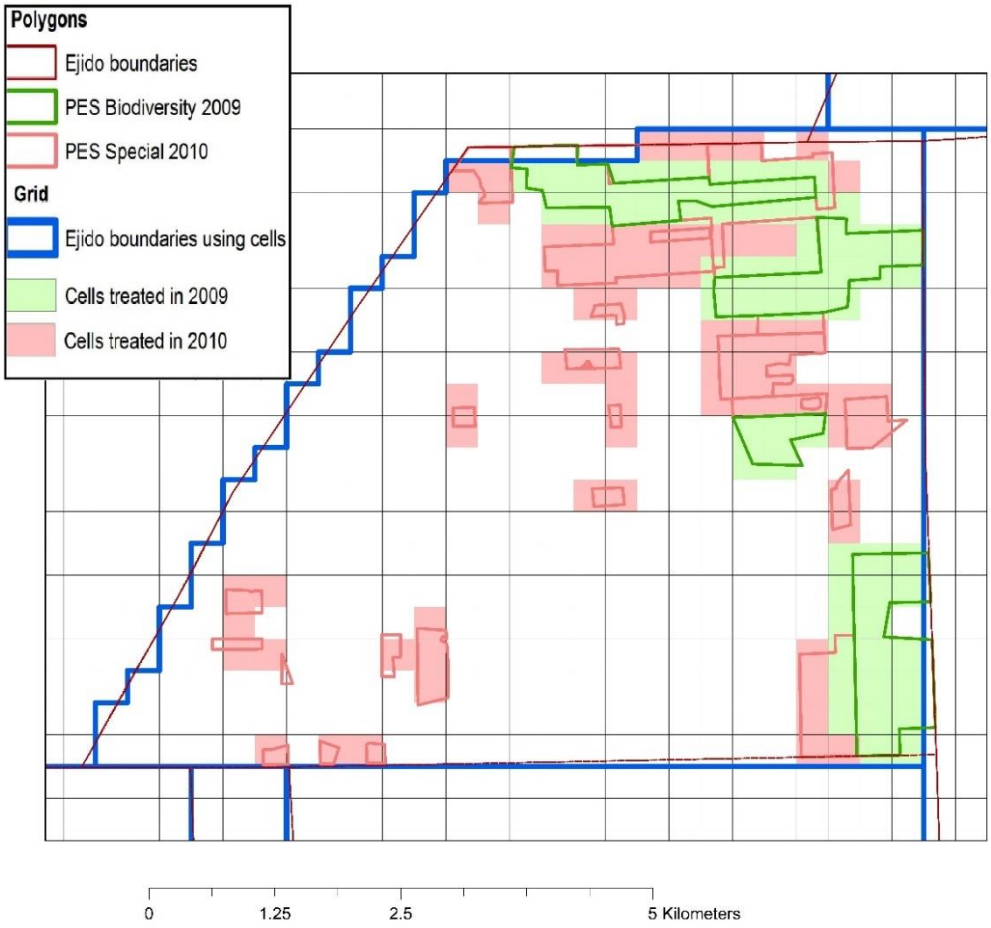
As the program is voluntary, forest owners can decide not to participate in the program regardless of the level of forest cover found in their properties. In the case of *ejidos*, the decision to participate is a collective choice decided by the *ejido* assembly, which is the most important decision-making body made up of all right holders. The parcels included in program funding applications can involve all or a portion of or the community's commonly managed forests, or selected forested parcels controlled by households. Applicants can hire technical service providers to develop their application proposal and payment-targeted parcels are geo-referenced as polygons. Once an application is approved by CONAFOR, the proponent(s) must design a forest management plan on the contracted polygons, which is also developed with service providers' support.

3.1.3 Unit of analysis and data sources

Ideally, the analysis should aim at comparing forest conservation outcomes within PES polygons with similar un-treated polygons. However, the polygons are generated exclusively for the needs of PES contracts, therefore there is no database of un-treated polygons. Nevertheless, information systems are well developed in Mexico (Sims et al. 2014) and the National Agricultural Registry (RAN) provides *ejidos* and communities information about land tenure. Data sources are published in different formats. Physical and land use information are defined at a pixel level while program and administrative data are available as polygons. Because all data sources are georeferenced, it is possible to build a spatially explicit database containing both treated and non-treated units.

In this research, the unit of analysis consisted of exogenous regular grid cells. Grid cells helped address the lack of tenure data at the plot level and allow to integrate information from different geographical and administrative scales. The spatially explicit grid was composed of regular squares of 10 hectares, approximately a side length of 316 m, which was below the minimum PES minimum eligible area. Grid cells did not correspond strictly to decision-making units (Miteva, Pattanayak, and Ferraro 2012; Honey-Rosés, Baylis, and Ramirez 2011) (Figure 7. Transformation occurring using grid cells as unit of analysisFigure). However, using grid cells helped capturing a variety of land uses within each *ejido*. In addition, within a treated *ejido*, areas treated by the PES program were considered distinct from un-treated parcels.

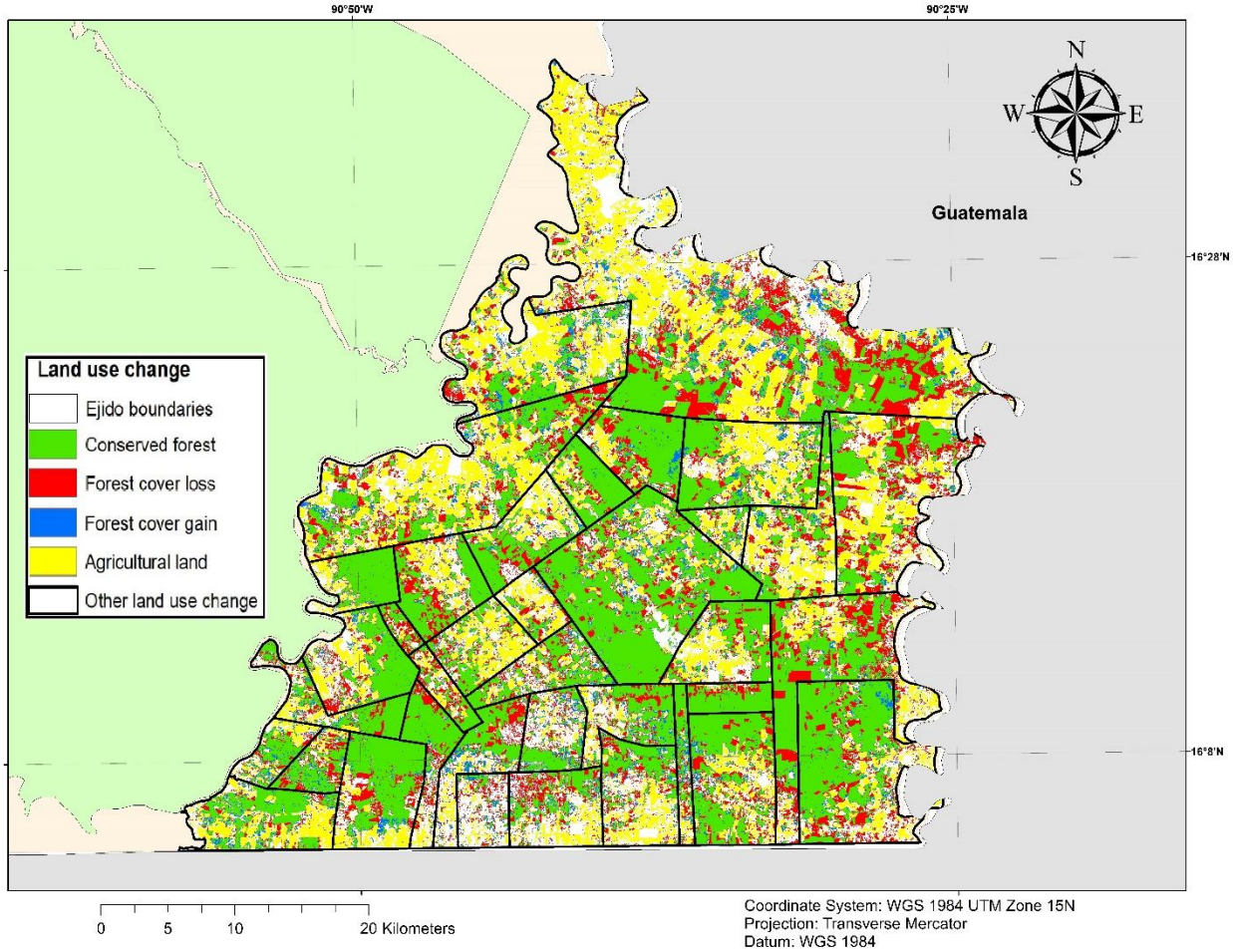
Figure 7. Transformation occurring using grid cells as unit of analysis



Note. The unit of analysis is based on an exogenous regular grid. Due to the irregularity of PES polygons and *ejido* boundaries, the shapes can be altered. Here is the case of an *ejido*, which has received two PES contracts, one starting in 2009 and one started 2010.

I acknowledge that the main limitation in using cells for comparison purposes is a distortion at the boundary between two communities: such boundaries are irregular and a grid cell may overlap with two communities. Therefore, to categorize a cell as being in one community or another, the location of each cell's centroid was used to determine the community information associated with that cell. Visual interpretation of community boundaries indicated that, in the municipalities selected, there was no evidence of any forest encroachment from one community into another, as community boundaries were easily distinguishable by contrasting land uses (Figure 8).

Figure 8. Land use change (2007–2013)



Note. Land use change map is obtained by the classification of two Spot 5 images. The classification is supervised with a maximum-likelihood process completed with manual correction in areas with spectral confusion. This map presents only land use changes related to

forest cover and agricultural land. Land use change map has been elaborated by the author using Spot 5 satellite images using ERDAS IMAGINE 9.2.

Grid cells were also used to capture additional information from other datasets, in particular: i) biophysical features of the landscape (land use, elevation, slope, soil characteristics) and ii) administrative and census data that was assumed to be common across all cells in the same community. Spot 5 satellite images (10-m resolution) for 2007 and 2013 were used to detect land use changes (Figure 8). For each year, two maps comparing land cover were generated to capture changes before and after the implementation of PES contracts for the first cohort of interest. Eight land-use classes are considered: mature forest, disturbed forest, other vegetation, cultivated lands, rivers, wetlands, urbanized area and undefined area (e.g. roads, clouds or shadows). These classes are a simplification of the classification used by (Soto-Pinto, Castillo-Santiago, and Jiménez-Ferrer 2012). This classification, however, has the advantage of making a neat distinction between different vegetative covers, particularly distinguishing mature from disturbed forests in regeneration, being the former the target of the PES program.

In the study area, some forests are still very dense and a variety of native species can be found while other show signs of regrowth. Nevertheless, the classification does not differentiate natural regeneration from the introduction of new species; therefore the analysis was limited to measuring the evolution of forest cover instead of more precise biodiversity metrics. For each cell, total forest cover in 2007 and 2013 was calculated. The dependent variable took into account the area of forest conserved between the two periods (in ha) instead of a binary variable indicating forest conservation or not at pixel level. Continuous variables capture more information than binary variables, especially where selective logging is frequent (Honey-Rosés, Baylis, and Ramirez 2011).

The database also included a Deforestation Risk Index, which is computed by the National Institute of Ecology and Climate Change (INECC) and is used in PES programs targeting across

the country (Alix-Garcia, Sims, and Yañez-Pagans 2015). This index predicts the risk of forest loss based on an econometric model calibrated with data related to deforestation drivers from 2000 to 2007. The index is presented in the form of a probability of deforestation (from 0 to 1) computed at pixel level. Theses pixels are aggregated to obtain an average deforestation probability at cell level.

Data were completed with a digital elevation model (DEM) elaborated by the National Institute of Statistics and Geography (INEGI), available for all Mexican territory. Arcgis® was used to calculate altitude and slope and to aggregate the information at cell level. Information from a geomorphologic database on soil quality was also added (García-Gil and Lugo Hupb 1992). Soil quality indicates land suitability for agriculture since it influences relative land productivity. Soil classes include steep slopes, alluvial plain, structural plain, lake plain, eroded land and river valley. Alluvial plains are the most fertile class. Nevertheless, the impact of soil quality on deforestation is ambiguous: indeed, a more productive soil type could increase deforestation to maximize profits but it can also help to conserve forests by facilitating more intensive agricultural practices that require less land. For each cell, spatially lagged variables for all the available physical characteristics (elevation, slope, forest cover and deforestation risk) were computed. Geoda® was used to calculate these variables using a queen contiguity matrix (W matrix) (Honey-Rosés, Baylis, and Ramirez 2011).

Data also included census data from INEGI at the *ejido* level. The census provides other demographic information and an asset-based marginality index used as a proxy for poverty levels. Data from the 2005 census were used as pre-program values for *ejidos* and data from the 2010 census were extrapolated as post-program values. Consequently, all cells of an *ejido* have the same values for these census variables.

Finally, it is worth remarking that the subsequent analysis is restricted to communities that joined the PES program in 2008 or 2009, since these were the largest participating cohorts of

the study area. For a cell to be considered treated, at least 0.5 ha had to overlap with the PES polygon in the less restrictive classification, and 8 ha in the most restrictive classification. Cells with lands belonging to another PES cohort were excluded because these cells had been already treated and would have introduced bias. When a cell overlapped with two or more PES polygons within the same *ejido*, the cell was considered as treated by the earlier PES contract.

3.1.4 Estimation procedure

Data were pre-processed using matching techniques to reduce the sample to treated and un-treated units with similar observable characteristics. Two sources of possible selection bias were considered, one at the parcel level (*ejido* members can choose to include some but not all community forests) and another at the *ejido* level (some communities have the ability and the desire to collectively engage in PES while others do not).

The analysis was based on a two-step matching procedure. The first step involves the identification of pairs of similar *ejidos* based on observable characteristics. For each treated *ejido*, the most similar non-treated *ejido* in terms of socio-economic and demographic characteristics was identified. The matching was based on the following variables: distance to the nearest city, years since *ejido* creation, size, population with property rights, and other demographic information (i.e. total population, proportion of people between 15 and 64 years-old, number of people who have been in secondary school, and socio-economic marginality index calculated by Mexican statistical agency).

In a second step, matching was performed with physical variables at cell level. Specifically, each cell receiving PES in 2008 or 2009 was matched with comparable cells from *ejidos* not receiving PES. The following biophysical characteristics were used in the matching specification: forest area in 2007, elevation, slope, deforestation risk index and the spatial lags for each of these four covariates. An exact matching on the dominant soil in the cells was added,

which served both as an index of relative soil productivity and as a way to control for the geographic location of the cells. Indeed, visual interpretation of the region's geomorphological map suggested that alluvial soils bordering rivers and protected areas while other soil types were more present in remote areas. The set of physical variables was assumed to capture opportunity costs at parcel level. Therefore, for each treated parcel of a treated *ejido*, matched cells corresponded to the more similar cells elsewhere located in an *ejido* not involved in PES. As this two-step matching procedure could still contain some unobservable bias, results were further compared with other specifications (described below).

Matching estimation was corrected by a bias-adjustment procedure aiming at obtaining valid confidence intervals as proposed by (Abadie and Imbens 2006). Covariate balance was assessed through mean-comparison but also standardized bias statistic (difference in means weighted by the difference of standard deviations) to assess covariate balance (Rosenbaum and Rubin 1985). Sensitivity analyses were performed i) by discarding the worst 5% match according to Mahalanobis distance and ii) by using two matches per treated cells instead of one. Sensitivity of the results to the thresholds used in the construction of the database are also tested. The first threshold was the minimum forest area chosen to distinguish a forested cell from a non-forest (from a minimum forest area of 1 ha to an area of 0.1 ha). The second threshold was related to the definition of treated cells. Different overlaps between a cell and a PES polygon were considered (0.5, 2 and 8 hectares). The variation of this threshold either conserved or eliminated cells located at the boundaries between enrolled and un-enrolled forest parcels.

Once a balanced sample was obtained through the matching procedure, a difference-in-difference (DID) estimator was used to measure the Average Treatment Effect among the treated units. Two forms of DID estimators are used i) an Ordinary Least Square (OLS) model and ii) a Panel Fixed-Effects (FE) model. The OLS specification contained the set of physical and socio-economic variables likely to have an influence on forest conservation independently

of PES payments (Bertrand, Duflo, and Mullainathan 2004). The FE model could not take into account eventual serial correlation because only two time periods were available. Nevertheless, panel variables were used as proxies for eventual change in decision-making capabilities to account for variations in social and demographic characteristics at *ejido* level. These variables included the evolution of total population, marginality index, proportion of active population (between 14 and 65 years-old) and proportion of people with secondary education.

3.2 Results

3.2.1 Comparing computed deforestation risk with deforestation rate in treated and non-treated parcels

Results show that, on average, non-treated parcels in treated *ejidos* have a higher deforestation risk than treated parcels (respectively 0.074 against 0.066) (Table 1, line E and F). This is consistent with the fact that the deforestation risk index is a proxy for opportunity costs. Indeed, forests with low opportunity costs are more likely to be placed under the program by *ejidos*' right-holders because the payment received to conserve is higher than the expected profitability of alternative land uses on the allocated lands. Data show that the average deforestation risk in non-participant *ejidos* is similar to the deforestation risk in treated parcels (Table 1, line E and I).

The results for treated parcels can be decomposed by year of first entry into PES. The first parcels to enter the PES program in 2005 had a very low deforestation risk. This finding is consistent with observations made by (Muñoz-Piña et al. 2008; Alix-Garcia, Shapiro, and Sims 2012) and with the fact that the use of the deforestation risk index to select eligible areas for payment under Mexico's PES programs was only introduced in 2007 (Sims et al. 2014). Indeed, parcels entering the PES program in 2008 have a higher probability of deforestation (0.075 on average) than previous cohorts. As the stock of forest is limited, forests entering PES in later

cohorts have a lower deforestation risk -although higher than for the 2005 cohort, which, however, is similar to the average of non-treated parcels in treated *ejidos.*

Table 1. Deforestation risk and forest cover loss by cohorts of participants and non-participants

Parcels		Total area (10^3*ha)	Average Risk index (*100)	Forest cover in 2007 (10^3*ha)	Forest cover in 2013 (10^3*ha)	Forest loss (10^3*ha)	Forest loss (%)	Deforestation rate (%)	Forest loss in considered parcels as a percentage of total studied area
PES parcels	Since 2005 (A)	3.13	4.8	2.79	2.67	0.12	4.13	-0.84	0.4
	Since 2008 (B)	9.57	7.5	6.87	6.38	0.49	7.17	-1.48	1.71
	Since 2009 (C)	7.33	6.7	5.04	4.45	0.59	11.66	-2.45	2.03
	Since 2010 (D)	12.55	6.5	8.85	7.78	1.06	12.03	-2.53	3.69
Participant *ejidos*	Subtotal PES parcels (E)	32.58	6.6	23.54	21.28	2.26	9.6	-2	7.83
	Subtotal non PES parcels (F)	46.54	7.4	31.83	21.29	10.54	33.14	-7.73	36.54
	Subtotal *ejidos* treated (G)	79.12	7.1	55.38	42.57	12.81	23.13	-5.12	44.36
Non-participant	Subtotal *ejidos* non treated (I)	67.64	6.7	42.47	26.41	16.06	37.82	-9.07	55.64
Total		146.76	6.5	97.85	68.98	28.87	29.51	-6.75	100

Note. The predicted deforestation risk index and the occurred deforestation are calculated for different groups of parcels. First, cohorts of PES plots are compared, by distinguishing the year of first involvement into a PES contract. Second, data are aggregated in order to compare treated and non-treated plots within participant *ejidos*. As well, information on non-participant *ejidos* is provided.

In 2007, roughly half of the total area of the two municipalities was covered in primary forest, for a total area of 97,852.5 hectares (Table 1, third column). By 2013, total forest cover was reduced to 68,980.6 hectares, which represents an average annual deforestation rate of 6.75%. From the summary statistics, it appears that there is little relation between the predicted deforestation risk and actual deforestation. If the local conservation programs are successful,

this lack of correlation makes sense: conservation programs target parcels with significant deforestation risk and programs are ideally translated into reduced forest cover loss on those parcels.

A majority of deforestation (55.64%) occurs in non-treated *ejidos*, which have lost 37.82% of primary forest cover between 2007 and 2013 (Table 1, line I). However, non-treated parcels of treated *ejidos* also face a high deforestation risk but have lost relatively less forest over the same period. This observation can be interpreted from two opposite perspectives. On the one hand, PES participating *ejidos* might increase their conservation practices even on un-enrolled parcels as a positive spillover of the program. On the other hand, participant *ejidos* would have probably conserved more forests than non-participant *ejidos*, even in the absence of the program.

Considering compliance with PES goals, 7.83% of forest loss in the study area has been lost within PES polygons, mainly due to selective logging. It means that the PES contract terms have not been completely enforced, which can in turn be explained by the fact that PES contracts prohibit land use change but do not have explicit criteria for forest cover. Therefore, it is indicative that selective logging is informally allowed and not sufficiently monitored and sanctioned by government officers, which might contribute to forest degradation even within polygon boundaries. It is worth highlighting that forest cover loss is more prominent in parcels recently contracted under PES. However, forest loss on these parcels should be interpreted cautiously since there is no information on whether these losses occurred before, during, or after the PES contract for the parcels entering the program in 2010 and beyond entered into force.

3.2.2 Measuring PES additionality for 2008 and 2009 cohorts

The matching procedure previously described is performed. The following table shows the performance of the matching procedure in terms of covariate balance (Table 2).

Table 2. Covariate balance after matching

	Treated (n=1413)		Control with matching on physical and socioeconomic characteristics in non-treated *ejidos* (n=761)			
	Mean	SE	Mean	SE	% bias	p-val.
Forest area 2007 (ha)	8.43	0.06	7.9	0.09	16.8	***
Elevation (m)	175.04	0.58	178.06	0.68	-12.1	***
Slope (%)	1.89	0.06	1.6	0.05	15.8	***
Deforestation risk	0.07	0	0.07	0	0.5	0.89
Ejido size (ha)	5211.8	85.3	5125.1	106.38	1	0.54
Years since *ejido* foundation	36.18	0.24	33.11	0.31	31.4	***
Distance to city (km)	253.41	0.47	255.69	0.62	-15	***
Marginality index in 2005	0.11	0.62	0.21	0.02	-15.5	***
Population in 2005	484.35	12.43	537.78	15.93	-2.8	0.01
Active population (%)	0.52	0	0.51	0	29.5	***
W*Forest area 2007 (ha)	7.44	0.06	6.93	0.08	19	***
W*Elevation (m)	174.71	0.55	178.17	0.66	-14.1	***
W*Slope (%)	1.84	0.05	1.61	0.04	16.1	***
W*Deforestation risk	0.07	0	0.06	0	6.2	0.11

Note. Control group is obtained from the two-step procedure described in previous section. Distribution of variables between treated and control groups are compared using two statistics: the p-value of mean-comparison test and the standardized bias difference in percentage. Standardized difference is the difference in percentage in average covariate values, divided by the square root of the sum of variances for both groups. W is the spatially lagged value using a queen contiguity matrix (average value of the eight cells that share a boundary with the cells of interest). *** corresponds to a p-value< 0.01.

Overall, the procedure contributed to improve covariate balance between treated and non-treated groups, but the statistics used to describe covariate balance confirms that a bias on observable characteristics is still present. The p-value of the mean-comparison test only takes into account the fact that treated and untreated samples means are significantly different (in the case of a p-value superior or equal to 0.01) while the standardized bias difference better considers variable distribution. A standardized difference inferior to 20% in absolute value is generally considered as an indication of a good covariate balance.

In the studied sample, the two statistics provide contradictory information about which variables are unbalanced. According to the standardized bias difference, the number of years

since *ejido* foundation and the percentage of active population are poorly balanced in terms of variable distribution. Therefore, even after the matching procedure, the treated and un-treated sample have different distribution of characteristics considering these two variables. As well, considering only sample means, deforestation risk, *ejido* size, population in 2005 and spatially lagged deforestation risk are not balanced. This suggests a certain limit of the matching procedure consisting in the difficulty to associate similar untreated units to each treated unit when the studied area is small and considerably heterogeneous. However, even if the matching procedure does not generate perfectly balanced samples, the observable bias has been reduced.

Sensitivity analysis was performed to assess the degree to which covariate balance was affected by different matching specifications (Table 3 and Table 4). First, two other matching procedures were tested (Table 3). Alternative procedure A compare parcels treated in 2008 and 2009 to matched non-treated parcels within *ejidos* that have received PES. The matching is only based on biophysical characteristics described in the previous section. As not all forest belonging to a community are included in PES contracts, this procedure assumes that forests not-included in PES contracts can represent a counterfactual of forests included in the contract, at the condition that there are no unobservable factors likely to explain why some forests are included in PES programs and other are not. Alternative procedure B also only considers biophysical characteristics but the control group is limited to forested cells belonging to *ejidos* not participating in the program (between 2005 and 2012). This procedure is then based on the assumption that specification A might not take into account eventual internal leakages effects or unobservable systematic differences between treated and non-treated forests within an *ejido* participating in PES. Procedure B instead assume that a comparison based on biophysical characteristics is only valid if non-treated cells corresponds to forests in *ejidos* that did not participated in PES.

Results show that the chosen specification (two-step procedure) considerably reduces the number of units used as controls. In all cases, the number of units used as control is lower than the number of treated units, so some control units are matched several times to treated units. In terms of covariate balance, the sensitivity analysis indicates that no specification is able to generate balanced samples over the 14 variables used to characterize balance. Nevertheless, alternative specifications do not perform better than the two-step procedure. As this procedure is assumed to better take into account biophysical and socio-economic variables potentially biasing any estimation of PES effectiveness, the procedure is preferred over alternative specifications.

Table 3. Sensitivity of ATT to matching specifications

	Control with matching on biophysical and socioeconomic characteristics in non-treated *ejidos*	Control with matching on physical characteristics in treated *ejidos* (A)	Control with matching on physical characteristics in non-treated *ejidos* (B)
n treated	1413	1413	1413
n control	761	805	1111
Variables with bias <20%	10	9	10

Note. Bias corresponds to the standardized bias difference in percentage. Shaded area indicates the results obtained from the two-step procedure.

The sensitivity analysis also considers the effect of matching parameters such as i) choosing two matches per treated observation instead of one and ii) only keeping the best 95% matches (Table 4).

The analysis of the matching specifications suggests that results are relatively sensitive to the threshold used to determine minimum forest cover and minimum PES overlap (Table 4). Holding constant the PES overlap area but reducing the minimum forest area from 1 ha to 0.1 ha appears to systematically reduce the program impact in all the specifications. This difference suggests that the PES program is less effective in the conservation of small forested areas than

for more compacted areas. This result is checked by analyzing how estimates of additionality resulting vary with changes in the minimum PES overlap. The 8 ha threshold restricts the treated units to only those largely overlapping PES polygons and, when doing so, the additionality diminishes. This result can be explained by the fact that some cells imperfectly overlapping PES polygons were considered as treated with a less strict threshold but became considered as control now.

Table 4. Sensitivity of ATT to matching parameters and thresholds

	Minimum forested area	0.1 ha		1 ha	
	Minimum PES overlap (ha)	0.5 ha	2 ha	2 ha	8 ha
Match 1:1 (1)	n treated	1,646	1413	1413	707
	n control	888	793	761	435
	Variables with bias <20%	10	10	12	10
Best matches (95%) (2)	n control	859	773	742	431
	Variables with bias <20%	9	10	11	12
Match 2:1 (3)	n control	1374	1237	1208	738
	Variables with bias <20%	9	10	11	10

Note. This table assesses the sensitivity of covariate balance to different matching parameters and threshold used to define the unit of analysis. (1) is a 1:1 matching based on Mahalanobis distance with replacement. (2) only considers the best 95% matches of the 1:1 matching. (3) corresponds to a 2:1 matching with replacement. Results also vary in function of the minimum forest area and the minimum overlap with PES polygons.

Using the sample obtained from the two-step matching procedure, results from both OLS and FE models give a significant estimation of program impact (Table 5). The interpretation of the Average Treatment Effect requires to take into consideration that the estimation is based on the area of forest conserved between 2007 and 2013 in grid cells of 10 ha. Therefore, a forested cell included in PES programs in 2008 or 2009 has on average additionally conserved between 1.1 and 1.13 ha of forest, compared to forested cells used as control groups. As the treated sample contains 1413 treated cells, the average avoided forest loss is 1554.3 ha, which represent roughly 14.5 percent of the area put under PES in 2008 and 2009. This results is sensitive to

matching specifications but remains between the confidence interval characterized by the Standard Error.

Table 5. Robustness of specifications using difference-in-difference estimation

Matching DID with OLS	ATE	Standard
	1.1***	0.17
Matching DID with Fixed Effects	ATE	Standard
	1.13***	0.10

Note. *** corresponds to p-value< 0.01. This table provides ATE estimated from two Difference-in-Difference (DID) estimations. OLS estimation is based on control variables likely to explain conservation outcomes (elevation, slope, years since *ejido* foundation, *ejido* size, proportion of commons area, total population, proportion of active population, proportion of people with secondary education, number of right holders, distance to nearest city and marginality index. DID in panel version using a fixed-effect is based on variables in two time dimension 2005 and 2010 (marginality index, population, proportion of active population and proportion of population with secondary education). The information for 2010 is used as an extrapolation of data for 2013.

3.3 Discussion

The results highlight that Mexico's PES program for biodiversity conservation has been effective in enrolling areas that generally show high deforestation risk. On average, treated parcels in recent cohorts and un-enrolled parcels have similar deforestation risk, which suggests that participation in PES cannot be explained only by land opportunity costs but, as other studies have suggested, also by factors related to collective decision-making and local governance (Kosoy, Corbera, and Brown 2008). The program has led to additional forest cover protection in comparison to what would have been expected in the absence of payments. The analysis also reveals that additionality can be achieved despite low compliance levels in some PES areas (i.e. plots under PES lands have been losing around 10% of forest cover during the contract). Lack of compliance can be explained by constrained forest governance at collective or household levels coupled with deforestation inertia, as well as by the government's insufficient enforcement of program rules.

Besides, un-enrolled parcels of treated *ejidos* have been less deforested than parcels of non-treated *ejidos* despite a higher deforestation risk index for the former can imply the presence of

a positive spillover of the program. For example, some treated *ejidos* in the area have been able to successfully develop ecotourism projects in parallel with the enrollment of their forest program (Carabias et al. 2009). However, asserting the existence, drivers and consequences of these behavioral and collective responses with full confidence would require extensive ethnographic work at community level (see chapter 6).

Overall then, given that deforestation has proceeded apace in non-PES and a minority of PES targeted areas during the study period, the PES program has been insufficient to halt deforestation at municipal level. This outcome is explained by the existence of incentives to convert forest lands to more profitable land uses such as oil palm cultivation (Soto-Pinto, Castillo-Santiago, and Jiménez-Ferrer 2012; Carabias, Meli, and Hernández 2012), resource management competing interests and forest governance failures at *ejido* level, and lack of enforcement of the PES program by CONAFOR. The long-term permanence of current high additionality levels in the studied municipalities is likely to be dependent upon sustaining payments over time and keeping PES targeted areas sufficiently large, in combination with alternative conservation strategies ranging from improved command and control approaches to investment into more diversified forest agricultural economies. A comprehensive conservation and development strategy appears as the necessary next step to take into account all together conservation priority zones, biodiversity corridors and agricultural development hot spots (Barsimantov and Kendall 2012).

As regards to the methodology employed, robustness analysis confirms additionality but variations are found when testing for different classification thresholds particularly the size of the forest parcel and the level of overlap with the PES polygons. Overall, such analysis suggests that grid cells have many weaknesses as a unit of analysis, mainly because they imperfectly correspond to decision-making units (Baylis et al. 2015; Le Velly and Dutilly 2016). In the Mexican case, it is important to highlight that forest polygons can encompass three types of

tenure arrangements, namely: *de jure* commonly held and managed land; *de jure* commonly held land but *de facto* divided by the assembly and household managed; and *de jure* household-owned land. In the absence of accurate information related to these different property arrangement as well as a clear definition of internal and external tenure boundaries, grid cells can only approximately measure the effectiveness of PES in collectively-owned forests.

As a corollary, measuring of additionality at this level of analysis does not consider eventual leakage phenomena such as the displacement of deforestation from PES polygons to non-treated areas, especially in *ejidos* that do not participate to PES programs. For example, discussions with local forestry consultants have revealed that some community members receiving PES have used the payments to rent land in other communities not involved in PES programs, potentially displacing deforestation from a participant community to a non-particiapant. These micro-levels decisions are very complicated to take into account without exhaustive data collection. However, it is possible to consider that such decisions remained marginal and that deforestation trends outside PES polygons are relatively unaffected by PES programs.

Considering other analysis of effectiveness carried-out in Mexico (Alix-Garcia, Sims, and Yañez-Pagans 2015; Alix-Garcia, Shapiro, and Sims 2012), the results presented in this chapter are considerably optimistic. The program's positive impact on forest conservation can be explained by the fact that this analysis is performed at a very local level (two municipalities) while these other studies consider PES participants in several Mexican states. As the study area is considered as one of the most deforested in the 2000's, the results highlight the fact that PES can be additional in areas facing important deforestation risks. The influence of the scale of analysis in the measurement of effectiveness has also been found in Costa Rica, where analyses performed in a region characterized by important deforestation found more important

additionality than analysis performed at national level (R. Arriagada et al. 2012; Robalino and Pfaff 2013).

Further research is needed to understand under which conditions PES can contribute to avoid deforestation. Impact assessment techniques have rapidly emerged as sophisticated methods to measure PES effectiveness, but evidence on the influence of many ecological, social and institutional factors over effectiveness.

3.4 Summary

This chapter has proposed a methodology to measure the environmental effectiveness of PES contracts in 13 rural communities located in the southern state of Chiapas, Mexico. The methodology was based on a two-step matching procedure using spatially explicit data at the intra-community level to define a credible counterfactual of forest conservation outcomes. Units of analysis consist of regular grid squares allowing to syntheses several sources of information (land-use change, socio-economic census, PES programs polygons) and to take into account intra-community variability. Performing impact evaluation in collectively-owned forests is not straightforward due to the lack of accurate data related to land-use change decisions shaped by complex tenure arrangements. The procedure has several weaknesses but allow to approximate the measure of PES effectiveness in a cluster composed on several participant and non-participant communities.

The following chapter explores the role of technical service providers and notably their influence over PES participant selction, program implementation and the articulation of PES incentives with other institutions shaping forest management.

4. The influence of technical service providers in PES implementation

This chapter examines the role of technical service providers in the implementation of PES contracts in the state of Chiapas. This chapter addresses the second research question *"How do technical service providers adapt to and influence PES implementation in rural communities?"*. The contribution of this chapter is to explore the diverse profiles of technical service providers involved in the implementation of PES programs in Chiapas and to understand how they respectively adapt to the challenges characterizing PES implementation in rural community contexts.

The findings of this chapter are based on the analysis of qualitative data collected through semi-structured interviews and participant observations carried out in 2013 and 2014. Data analysis is notably based on semi-structured interviews collected among 15 out of the 27 technical service providers (TSP) active in the state of Chiapas in 2014. This chapter shows that the profiles of TSP are quite diverse and recover various types of actors such as individual technicians, professional consultants and conservation NGOs. In turn, all TSP work in complex and uncertain contexts, notably due to the evolution of PES procedural rules but also due to the difficulties in interacting with community members. Nevertheless, results show that some TSP have been able to concentrate an important number of PES contracts in circumscribed areas, subsequently enhancing their influence over communities located in these areas. On contrary, less experimented TSP have had more difficulties interacting with community members and it has affected the degree to which community members can collectively participate to PES implementation. Overall, the findings of this chapter contribute to the debates about the importance of technical intermediation in mainstreaming PES among community institutions but also shed light on how the heterogeneous organizational capacities of TSP can amplify territorial inequalities.

The chapter first describes the methodology used to collect data on technical service providers. Section 4.2 classify the TSP in function of their organization characteristics and their motivations to work as TSP. Section 4.3 presents how TSP perceive the complexities of the PES procedural rules and notably how it affects their relation with participant communities. Section 4.4 discusses the results.

4.1 Collecting data on technical service providers

4.1.1 Selection of interviewees

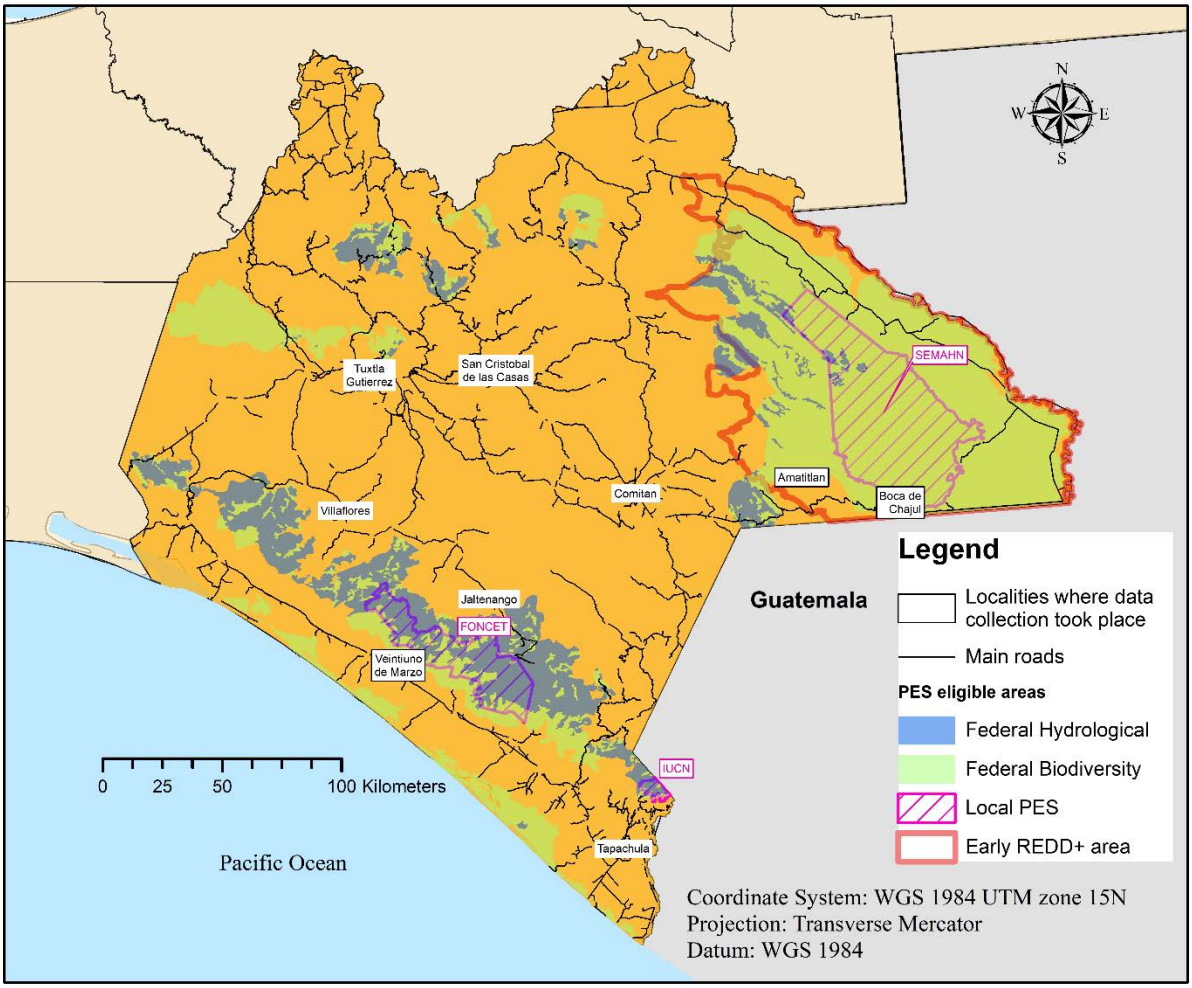
Since 2008, CONAFOR publishes the list of technical service providers (TSP) accredited to work in each federal program managed by the agency, including but not limited to PES programs, for all the Mexican states. While the first list only gave the name of accredited TSP and the programs that they can provide assistance for, since 2010 contact details such as phone number and e-mail address are generally also provided. Some of these TSP have been contacted between October and December 2013 when I was exploring how PES have been implemented in the state of Chiapas. Two former and three current TSP have been interviewed through unstructured interviews in order to understand what have been their motivations to become TSP and how they perceived the strenghs and weaknesses of PES as they have been implemented in the state of Chiapas. This information has been collected trhough field notes.

Complementary information has also been extracted from several participant observations performed in 2013 and 2014. I have notably been invited by officials from the Conservation Fund El Triunfo (FONCET, *Fondo de Conservación El Triunfo*), which is an NGO in charge of financing conservation activities in the Biosphere Reserve of El Triunfo, in the southwest of Chiapas. Since 2013, FONCET has promoted a local PES with *ejidos* located within the buffer area of the Biosphere reserve. I have accompanied two FONCET officials, respectively the PES

project coordinator and a TSP[5], when they provided training to PES participants in the *ejido* Veintiuno de Marzo, *municipio* of Mapastepec (3) and 31st of October 2013). I have also accompanied CONAFOR officials coordinating the Early REDD+ program of Chiapas when they explained the rights and duties of new PES participants, respectively in the *ejido* Amatitlán, *municipio* of Maravilla Tenejapa (12th of November 2013) and in the *ejido* Boca de Chajul, *municipio* de Marqués de Comillas (13th of November 2013). These two meetings gathered CONAFOR officials, representatives of *ejidos* starting new PES contracts in 2013 and their respective TSP.[6] I have also been invited on the 30th of June 2014 to a meeting at the headquarters of CONAFOR in Tuxtla Gutiérrez where CONAFOR officials explained the new rules of operation of the Early REDD+ program in Chiapas to most of the TSP working in that area. During these four participant observations, notes have been taken about the perceptions that TSP have about PES programs in general and how they interact with CONAFOR officials and community members.

Figure 9. Localities where data collection took place

[5] This TSP has been also interviewed in 2014 (I3 in Table 6).
[6] One TSP met in Amatitlán has been interviewed in 2014 (I12) as well as two TSP met in Boca de Chajul (I2 and I14). Respectively two other TSP met in Amatitlán and two other met in Boca de Chajul have been informally interviewed in 2013 but refused to performed again an interview in 2014.



Note. This map has been elaborated using data provided by INEGI (city location and roads) and CONAFOR (PES eligible areas). Areas in pink (FONCET, IUCN and SEMAHN) corresponds to the approximate eligibility areas of three local outsourced PES.

In 2014, the selection of respondents has been based on the list published on June 2nd 2014, which was the latest list published by CONAFOR when data collection took place (June-August 2014). 27 TSP able to supervise PES programs (through the hydrological and biodiversity modalities) have been identified in the state of Chiapas. Note that there is no specific list of TSP in relation to local PES or early REDD+ PES, because accredited TSP can supervise indifferently all PES modalities if their proposal is accecpted by CONAFOR. All the TSP having an e-mail address have been initially contacted by this medium in order to explain the research project and invite them for an interview. While most of the TSP didn't answered to the e-mail, reaching them by telephone few days after has been more successful.

Three TSP refused to participate to the interview in 2014 because they have been already interviewed in 2013 when I was familiarizing myself with the activities of PES TSP in Chiapas.. Three other TSP were not interviewed because it has been impossible to organize an interview while I was physically present in Chiapas and they didn't want to perform the interview by phone or through Skype. Another TSP refused to be interviewed because he recently renounced to his position as TSP and started working in a governemental agency but refused to explain his experience working as provider. Note that two interviews were performed but not recorded due to a failure in the recording device. Two TSP were not interviewed because they work in association with a service provider already interviewed, and therefore they considered that their answers would be exactly similar to those of their colleagues. Finally, two interviewees working for the same NGO have been interviewed simultaneously. Therefore, only 15 out of 27 TSP have been interviewed.[7] These 15 interviews nevertheless represent a great diversity of experiences, working in four different PES modalities and covering a great majority of PES eligible areas in Chiapas.

Each interview has consisted in a semi-structured interview aiming at understanding how respective TSP have started to supervise PES contracts, how they select participants, how they supervise PES contracts and what are their relations with other TSP and CONAFOR officials (Annex 2). The interviews generally lasted between 50' and 1h30' and were all recorded and later transcribed (Table 6). 8 interviews took place in a public place such as a park or a restaurant, 5 interviews were carried out in the office on the interviewed TSP and 2 were performed through skype. Regarding the 15 interviews recorded, 6 have been performed in

[7] During data collection, a TSP informed me that another TSP has been supervising PES contracts in Chiapas without being formally registered in the list of TSP published by CONAFOR. CONAFOR indeed allows exceptionally some TSP to supervise PES contracts when these TSP are starting the accreditation process. Because I have not been able to obtain her contact before visiting the area where she works, this TSP has not been interviewed.

Tuxtla Gutiérrez, 2 in San Cristóbal de Las Casas, 3 in Tapachula, 1 in Comitán de Domínguez, 1 in the city of Jaltenango de la Paz and 2 through Skype (2 other interviews were performed in the city of Villaflores, but were not adequately recorded) (Figure 9).

Table 6. List of interviewed TSP in 2014

	M/F	Date	Interview duration	City	Place
TSP1	M	25/06/2014	1h08’	Tuxtla Gutiérrez	Public park
TSP2	M	30/06/2014	1h21’	Tuxtla Gutiérrez	Restaurant
TSP3	F	01/07/2014	52’	Jaltenango de la Paz	Restaurant
TSP4	M	01/07/2014	55’	Tuxtla Gutiérrez	Restaurant
TSP5	M	05/07/2014	58’	Comitan	Office
TSP6	M	10/07/2014	1h28’	Tapachula	Restaurant
TSP7	M	10/07/2014	1h20’	Tapachula	Office
TSP8	M	10/07/2014	1h02’	Tapachula	Public park
TSP9	M	23/07/2014	1h19’	San Cristóbal de Las Casas	Restaurant
TSP10	F	25/07/2014	50’	Skype	
TSP11	M	28/07/2014	54’	Tuxtla Gutiérrez	Office
TSP12	M	28/07/2014	1h08’	Tuxtla Gutiérrez	Office
TSP13	M	28/07/2014	1h24’	Tuxtla Gutiérrez	Office
TSP14	F	01/08/2014	1h16’	Skype	
TSP15	M	06/08/2014	1h24’	San Cristóbal de Las Casas	Restaurant

4.1.2 Data analysis

The 15 interviews have been recorded in MP3 audio format. Each archive is identified only by the date and time of the interview while I kept the contact information of each interviewee. The 15 interviews have been transcribed to a text format by a hired research assistant, and the research assistant has assured that she will not share the information contained in the interview, and will destroy the audio and text archive at the end of the transcription.

I have myself transcribed field notes from previous interviews with TSP and participant observations to a text format. All the texts from all the interviews and field notes have been read extensively to identify some recurrent themes relevant to answer the research question.

Coding categories have been defined in relation with the following themes 1) the organizational characteristics of the respective TSP, notably in terms of human resources and the variety of programs they provide assistance for, 2) the number of PES contracts they are currently supervising and their geographic location, 3) their perceptions of the evolution of PES procedural rules and how they have adapted to these changes, 4) their criteria to select PES participants and how they contact them, 5) the challenges identified when implementing PES among community members and 6) their perceptions of the work of other TSP.

Statements corresponding to the respective themes have been extracted and interpreted in order to answer the research question. The following sections summarize the analysis of data.

4.2 Characterizing the diversity of technical service providers

In this section, the diversity of interviewed TSP is described. This description does not pretend to establish a representative typology supported by juridical-administrative categories or concepts from the sociology of organizations. Instead, the various profiles of TSP are identified through a combination of criteria extracted from the thematic analysis of qualitative data. Criteria includes i) a description of the administrative organization of the TSP (whether they work as independent, as a business or as an NGO), ii) the certification that they have to work as a TSP, ii) the importance of remunerated PES technical assistance in the total income of respective TSP, iii) the extend of the geographical area where TSP supervise PES contracts, iv) the number of PES contracts currently supervised, v) the frequency of interaction with participant community members and vi) their previous relation with supervised communities before the existence of PES. These criteria allowed us to identify four distinct categories of TSP: A) Independent TSP specialized in PES supervision, B) Independent TSP occasionally supervising PES contracts, C) Consultancies supervising PES among other types of programs, and D) conservation NGOs using PES to advance their organizational goals. The following sections describe each of these categories.

Table 7. Categories of TSP

	"Mobile" individual	PES as a side-job	Consultancies	Conservation NGO
Description	Independent, or collaboration between two or three independents	Independent (but other job apart PES supervision)	Consultancy constituted by equal business partners or by one business leader hiring staff as employees	Employees
Who is certified in PES?	Every individual certified for each program supervised (PES and other)	Every individual, but only in PES	Every partner or staff member as a different certification (PES and other) but work all together	Every partner or staff member as a different certification (PES and other) but work all together
Do PES constitute important source of income?	Income come nearly exclusively from PES and to a lesser extend other CONAFOR programs	PES supervision is mostly a side-activity performed in complement to other formal job	Income comes in majority from PES but other governmental programs (CONAFOR or other) represent a significant proportion of income	Income is not directly related to PES
Scale of intervention	State	One municipality	Two or three municipalities	One municipality
Number of contracts	4-5	1-7	5-6	5-6
Experience working with communities prior to PES	no	Yes	Yes	Yes
Frequency of interaction with participant communities	Occasional	Occasional	Regular in relation with various projects	Very regular
Motivations to supervise PES	Main economic activity	Maintaining relations with some communities	Obtaining funding to improve capacities of rural communities	Motivating institutional change

Note. These categories have been established through the interpretation of collected qualitative data and therefore are not necessarily representative of TSP working in Chiapas or in other Mexican states.

4.2.1 Independent TSP specialized in PES supervision

Independent TSP (N=4) are individuals whose income comes in major proportion from PES contracts. They hold a graduate degree in biology, forestry or agriculture and have generally worked as short-term consultants with CONAFOR or other governmental agencies before becoming certified TSP. They decided to become TSP after not being able to get a formal position (e.g. a work contract with a stable salary) in a governmental agency. They have generally started to work as TSP since 2008 when PES eligible areas and associated funding covered most of the forested areas of Chiapas. Three of them live around Tuxtla Gutiérrez, the state capital and one in San Cristóbal de Las Casas but they generally do not have formal office. Although they are here labeled as independent, in practice, TSP 1 and TSP15 worked in association with their spouse and TSP2 and TSP4 in association with two or three other independent certified TSP. Independent TSP usually also hold certifications to work as TSP in other CONAFOR programs such as reforestation or soil management and are interested in getting other certifications requiring better technical skills but currently lack the requisites and financial resources to obtain these. Getting certification is generally challenging as it requires some expertise in project management and GIS software that they did not have at the beginning of PES programs. All the interviewed TSP nevertheless succeeded in getting the certification after participating to various training session with CONAFOR officials.

As PES technical assistance represents their major source of income, independent TSP are constantly looking for new clients, whether they are collective or individual forest owners. As there are relatively few PES eligible areas close to where these TSP respectively live, clients are often located in several more distant areas. TSP2 even work simultaneously near the eastern coast of Chiapas, near the biosphere reserves located at in the middle of the state and around

the rainforest at the west of Chiapas. This wide operating area is associated with important logistics costs, mainly due to gasoline and lodging expenses. Ideally, all these TSP would prefer to get several clients in the same circumscribed area of Chiapas to minimize costs, but until now have been unable to obtain more than two or three clients from the same municipality.

Independent TSP are often the ones trying to work with communities not previously contacted by other TSP notably in the case of communities situated in remote areas or communities with "poor reputation" (i.e. considered unable to make collective decisions or known to not comply their contractual obligations). They usually spend considerable time convincing community members to hire them as TSP, involving several visits to establish preliminary contacts.

However, during interviews, they generally recognize that once a PES contract is approved, they only visit communities if this was procedurally required, i.e two to three times per year once the forest management plan is defined. They also acknowledge that they try to minimize the time spent in negotiations and training with community members. Instead, they strongly rely on community leaders such as elected community leaders or designated local group leaders to coordinate PES implementation at community level without having to be physically present.

These TSP rarely try to articulate PES with other interventions such as agriculture or eco-tourism, mainly because they do not have experience in managing these programs and do not hold the necessary certifications. Consequently, they mostly maintain relations with communities where they currently have a PES contract or where they expect to work in the future.

Overall, these TSP work in relatively precarious conditions, as they are rarely able to simultaneously manage three to four PES contracts while they face important logistics costs. One TSP, not belonging to this category, is notably very sceptic about this way of supervising PES contracts: *"It is not profitable, […], when you realize that you spend everything in*

gasoline, in transport, in housing or who knows what, because, because technical assistance, at least with CONAFOR is not, how to tell it, i mean it is not well paid in general, so you cannot become rich with that." (TSP 5).

These TSP are then particularly sensible to the evolution of PES funding and targeting strategy. They have therefore tried to maintain close relation with CONAFOR officials working in the headquarters in Tuxtla Gutiérrez in order to have the information about changes in PES procedural rules and eligible areas. As they have perceived that, since 2013, budget has been better affected to areas covered by local outsourced PES and REDD+ PES programs, they have contacted communities located in these areas and generally successfully obtained new clients there. Overall, all these TSP have also considered eventually becoming certified to work in other programs less affected by budget cuts, but had not find programs remunerating technical assistance as good as in the programs they were already supervising.

4.2.2 Independent TSP supervising PES as a side-job

Another category of TSP consists in individuals already having a stable occupation in another organization but supervising some PES contracts during their free time (N=3). Two of these individuals are research assistants (TSP 7 and TSP10) in universities and TSP3 is technician at FONCET. All of these TSP were very familiar with the communities currently supervised before the existence of PES programs. They have notably built very good relations with community members since several years, either in relation with a previous research project in these communities (TSP 7 and TSP10), or simply by living in the area since her childhood for the third one. These TSP therefore consider PES as a way to earn some extra money while maintaining relations with these communities.

TSP 3 and TSP7 worked with communities located close to their hometown while the third one resides in the state of Michoacán in central Mexico. They affirmed that technical supervision

has been only performed during week-end or holidays. Actually, TSP3 and TSP10 only respectively supervised one community, one covered by the local outsourced PES scheme sponsored by FONCET and one covered by the early REDD+ PES program. In both case, previous PES contracts of the biodiversity modality were already implemented before the diversification of PES schemes, and were therefore renewed taking into account these new modalities. TSP3 was currently supervising seven communities. Note that all these seven communities are all covered by the local outsourced PES scheme sponsored by FONCET, but this technician do not have the right to supervise PES during weekdays. Indeed, there are a clear separation between the technical assistance provided by TSP from the training provided by FONCET technicians. Overall, none of these three TSP are actively looking for new clients.

Preparing certification has not been perceived particularly difficult for these TSP because they were already familiar with most of the technical aspects. Each of these three TSP only had a certification for PES programs and did not consider obtaining another in the near future. All of these TSP are very familiar with the contextual characteristics of these communities, and affirmed that they have considerable trust from all community members. Nevertheless, they recognize that they are rarely successful in convincing community members to engage collectively in new projects without a strong involvement of their TSP. As each of these TSP only visit occasionally the communities, no specific projects beyond what is required by PES procedural rules have therefore been implemented.

4.2.3 Consultancies

Another category of TSP consists in organization legally operating as consultancies (N=6). These TSP have their own offices and hold various certifications to work in several governmental programs, not limited to the one sponsored by CONAFOR. TSP5 and TSP13 also supervise commercial projects such as forest plantations and the realization of Environmental Impact Assessment, and are considering stopping supervising PES contracts soon. For TSP9,

TSP11, TSP12 and TSP13, PES represent the huge majority of income. As TSP8 also work as a university professor in a university specialized in agriculture, PES supervision represent roughly 30% of his total income.

All the consultancies have been constituted by one of several partners and generally are sufficiently profitable to hire staff members. TSP8 and TSP12 are even able to regularly hire university students as interns. Business partners or staff members generally hold various certifications and therefore try to implement various programs in each community. Consultancies generally work in relatively circumscribed area often limited to two or three adjacent municipalities. Therefore, their operative costs are in general lower than independent TSP because they argued that the concentration of multiple contracts in the same reduce logistics costs.

Most of the consulting TSP were already working with client communities before the existence of federal PES programs. Consequently, these TSP often enjoy a considerable trust from community members and in turn know quite well the internal organization and conflicts within these communities. At the same time, they do not only collaborate with current elected community leaders but also with a small group of trusted community members with whom they have established privileged relations. These community members generally are former elected community leaders that TSP recognize as facilitators, notably in relation to motivate community members and comply contractual obligations.

In many cases, these TSP have been able to propose other programs to communities (e.g. forestry, agriculture or focused on land planning and community organization) and even consider that they might progressively diminish their involvement in PES programs if PES eligible and targeted areas do no coincide anymore with their own operative areas. Furthermore, these TSP are usually likely to implement other programs fostering the collective management

of natural resources and improving local livelihoods. Indeed, these TSP generally hold certifications to work in a wide range of programs and are therefore able to implement various interventions simultaneously in the same community.

Overall, their strategy is then based on maintaining a certain continuity in their intervention and they are therefore generally able to adapt PES requirements to the preferences and needs of community members, although most consulting TSP think that they are unable to transform community institutions in a way that increasing livelihoods of community members while improving forest management. Indeed, most of them recognize that PES, among other incentive programs, are critical to motivate participation of community members in collective activities.

4.2.4 TSP backed by organizations

The last category of TSP consists in individuals belonging to formal organizations. Among the interviewees, TSP6 is local staff member for IUCN and TSP14 belongs to an influential Mexican conservation NGO called Natura Mexicana. These organizations respectively work in a very circumscribed area limited to one or two municipalities (e.g. a watershed or the buffer area of a biosphere reserve). At the difference of TSP in other categories, these TSP often have an office within their operative area and therefore interact very frequently with the communities they supervise. The respective work areas of these TSP coincide with areas of considerable importance for CONAFOR, namely associated with a local outsourced PES and the early REDD+ PES program. The two organization were already involved in conservation activities with local communities before the introduction of PES, but consider that PES is an instrument that can help them to fulfill their organizational objectives.

Actually, TSP6, as staff member of IUCN, has contributed to establish a local outsourced PES in their work area, corresponding to the watershed surrounding the Tacana volcano at the southwest of Chiapas. In this case, TSP6 with another colleague working as TSP stated that

they passed TSP certification because at the beginning of the project, it has been impossible for them to find a TSP with enough skills to supervise PES implementation following IUCN guidelines. Since the establishment of the local outsourced PES, TSP6 has used his own accumulated experience to invite and provide training to other TSP, mainly belonging to the category of individual independents. IUCN strategy in this area is not to simply act as technical assistant but rather of using PES programs to improve local capacities for the management of natural resources.

PES technical assistance does not represent a major source of income for individual TSP or for the organization they belong to. TSP14 even stated that the budget allocated to technical assistance is in fact redistributed to the communities they work with. TSP14, and the organization she works with, are not necessarily interested in working with other TSP. Actually, Natura Mexicana staff is composed of many volunteer biology students from a leading university in Chiapas. The considerable staff members notably help to organize participative planning with community members, by organizing regular group training favorizing collaborative decision-making.

According to most of these TSP, PES are very attractive to community members because they represent considerable money obtained in exchange of limited efforts. Nevertheless, PES fails to stimulate a transformation of local practices and rules and therefore they are rarely sufficient to generate long-term environmental or social outcomes. Therefore, these TSP consider that management practices and rules should be collectively renegotiated and therefore they often try to better involve community members in PES decisions. In practice, participative approaches are used only punctually because it is often perceived as challenging to the elected authority. Overall, these TSP do not limit their intervention to PES implementation but rather to a broader strategy of better natural resource management structured around forest conservation.

The description of the identified typology has highlighted that PES programs has stimulated the emergence of technical intermediation among rural communities. Nevertheless, TSP organized in consulting offices or NGOs were often active in supervising communities before the existence of PES, and PES have been used as a complementary source of income or as a mean to reach their respective organization goals. In the following section, the typology is further characterized to understand how each TSP has adapted to the evolution of PES procedural rules.

4.3 Adapting to institutional and community contexts

4.3.1 Evolution of regulation enabling the activities of TSP in PES programs

This section first describes the evolution of regulation shaping the activities of TSP in PES programs. It also describes the current process allowing an individual or an organization to work as TSP.

While the presence of TSP was not explicitly required in the first PES rules of operation (2003 and 2004), renting their services has become mandatory since 2006. TSP in PES programs are nowadays professionals, accredited and certified by CONAFOR, who can be hired by forest-owners when they want to submit a PES feasibility study before initiating a PES contract. If the PES contract is accepted by CONAFOR, TSP also must supervise the design and implementation of the forest management plan required by PES contracts. Technical intermediation has become increasingly important in PES implementation due to the inability of many forest-owners to provide the information required by CONAFOR, e.g. georeferenced contract area or scheduled forest management plan (Corbera, Soberanis, and Brown 2009; Shapiro-Garza 2013) (Corbera, Soberanis, and Brown 2009). Therefore, the governmental agency has considered the consolidation of the sector of technical forestry services has a side objective of PES implementation.

Along the evolution of PES procedural rules, the activities of TSP have been increasingly regulated, notably regarding their remuneration, the criteria defining the eligibility area, the targeted characteristics and the content of PES feasibility study but also what is required in terms of community participation, training and monitoring. As a matter of fact, several internal program evaluations considered that the dependence to TSP is considerable and that these actors do not always have the skills or the ethics required to fulfill their obligation.

Regarding the remuneration of TSP activities, CONAFOR now distinguishes the pre-program phase from the implementation phase. While TSP have to establish a contract with potential participants, they cannot, in principle, make communities pay for their services at this phase. In the implementation phase, the remuneration of TSP is calculated in function of the number of hectares of forest under conservation but also the type of forest ecosystem characterized by eligibility areas. The formulation of forest management plan since 2008 has been seen as a solution to involve the community in the planning of activities, as well as having an objective base for the monitoring of activities. The plan has to be written with community members in order to schedule the activities that will be performed during the five years of the contract. The second year of the payment is conditioned to the validation of the document, the following payments to the fact that the expected activities have been performed. The content of the plan is regulated by CONAFOR, which provides guidelines such as a framework to diagnosis the local threats to forest ecosystems and a list of mandatory and recommended activities fostering conservation. Mandatory activities include prohibition of land-use change and overgrazing in forest covered by PES, the creation of vigilance committee and fire brigade, the display of signs referring to the inclusion of forests under a PES program and the participation to regular training sessions. Finally, each TSP cannot supervise personally more than eight contracts simultaneously, being obligated to transfer contracts to another TSP if the limit is reached.

Since 2008, TSP must be accredited by CONAFOR and since 2011 they have to follow a certification process in order to be hired as TSP. Accreditation has allowed CONAFOR to control the legal titles of TSP and publish the list and contacts of all TSP recognized by the agency. Furthermore, certification process consists in testing the qualifications of TSP and expelling the ones lacking abilities to perform activities such as designing PES feasibility study, providing training to community members and monitoring program implementation. Each certification costs 6000 MXN (around 425 USD), which represent a considerable cost for many TSP. TSP generally hold two or three certifications (e.g. reforestation or soil management). They can be certified as individuals (physical person) or as organizations (moral person). In principle, moral persons can manage more PES contracts than physical persons and can have access to more sophisticated programs managed by CONAFOR such as those related to forest plantations and improvement of social capital at community level.

Overall, the number of TSP has considerably reduced since 2011 (in a context of decreasing budget for PES programs). Remaining TSP are the ones who have been able to adapt to the evolution of PES procedural rules notably by developing contacts with CONAFOR officials, following capacity training and strengthening relations with eligible forest-owners.

From the perspective of TSP, the difference between the three existing PES schemes (federal PES, local outsourced PES and special REDD+ PES) only consists in minor difference in procedural rules and origins of funds. Indeed, once certified, an TSP can indifferently in all the PES schemes, as soon as the TSP is able to submit successful PES applications whit communities or private forests eligible to PES programs.

Most TSP are critical of overall PES targeting and implementation strategy. In general, most TSP have been affected by the decreasing PES budget. Even if areas explicitly targeted by CONAFOR, not all PES proposals have been funded. In particular, many PES feasibility studies

are characterized as “approved without funding” according to CONAFOR terminology, highlighting that in Chiapas the demand for PES greatly exceed the budget capacities. Furthermore, many TSP contest the coherence of PES eligible areas, stating that many forests of critical importance for ecosystem services are not considered eligible by CONAFOR. It is important to note that the TSP criticizing the most the definition of eligible areas are often the ones who do not work in areas covered by local or special PES programs.

Nearly all of TSP consider that the lack of continuity in PES contracts is potentially damaging for conservation objectives. Stricter procedural rules or difficulty to renew PES contracts when they finish indeed undermine the motivations of forest owners to engage in conservation. While the majority of TSP have heard disappointed community members threatening to destroy their forests if they do not receive PES, they observe that it rarely occurs in practice, partly because of the risks of governmental sanctions but mostly because there is no interests in doing so.

In relation with the overall functioning of PES, TSP are divided. Many consider that payments are indispensable to motivate community members. Nevertheless, TSP affirm that many community members think that they unconditionally deserve governmental subsidies and so that they consider that they are entitled to receive PES programs even if they do not meet requirements established by CONAFOR. Therefore, a minority of TSP is skeptical that PES is a good strategy to reach conservation outcomes. They consider that the major problems are not directly related to the compensation of opportunity costs but rather to transform community collective decision-making procedures, raising awareness over the importance of conservation and increasing the sources of incomes while reducing pressures on natural resources. The following section describes further the difficulty to interreact with community members in relation with PES implementation.

4.3.2 Working with complicated community contexts

As mentioned before, TSP are required for at least three phases of PES contracts: i) writing the PES feasibility study used by CONAFOR as a base to decide whether PES contract will be implemented or not in a given community, ii) PES contract implementation *stricto sensu* (training community members, designing forest management plan and coordinating PES implementation) and iii) monitoring contract compliance. In some case, community members already know PES programs and are therefore contacting directly an TSP in order to join PES programs. However, the relation between TSP and community members often critically begin when an TSP try to persuade community members to initiate the formalities to receive PES contracts. TSP should in that case gain trust from their future clients. It is not straightforward in all contexts (even if generally the demand for PES contracts exceed the funding capacities of CONAFOR) as many communities are initially reluctant to engage in such contracts. TSP often initially contact elected community leaders to describe the general functioning of PES programs, notably in communities which are not familiar with conditional contracts or with forest conservation programs. Afterward, if community leaders agree, TSP can introduce themselves to the community assembly. In turn, members of the assembly can decide if they want to contract the TSP and initiating the procedure aiming at receiving PES contract. Many TSP note that, at least at the beginning of a collaboration with a community, they have a very limited influence over internal community decision-making. It is notably often very difficult to work with communities where conflicts between members prevent consensual decisions. TSP should nevertheless collect all the necessary data to fulfill the PES feasibility study, notably the list of participants, a proof of property titles of community right holders and the georeferenced forested area that will be included in PES contracts.

All the TSP note that many PES feasibility studies are not always validated by CONAFOR, either because community members lack some officials documents to join PES programs, or simply because CONAFOR does not have enough budget to fund all the projects located within

PES eligible area. In those case, TSP should often justify such situation, as many community members suspect that the responsibility of such failure relies on TSP. TSP should then try to persuade community members to submit a new PES proposal the following year. Therefore, some communities have tried two or three times to join a PES contract, but generally many communities lost interest after two unfruitful tentatives.

If a PES proposal is accepted, CONAFOR provides a payment for TSP, calculated in function of PES contract area, independently of the specific payments received by communities. In exchange of such payment, TSP must fulfill several activities such as training community members, designing forest management plan and monitoring the implementation of conservation activities. As the first payment is delivered few weeks after a contract is approved by CONAFOR, the relation with the TSP are greatly facilitated. Indeed, community members generally become more enthusiastic about the presence of the TSP in the community and subsequently join the training sessions. Nevertheless, according to several TSP, many community members remain very passive during training sessions, mostly accepting quietly all the information delivered by the TSP. Many TSP insist on the repetitive aspect of training sessions, where the same information is repeated from one training session to another.

As well, newly elected community members can decide to refuse to pursue compliance with PES requirements, which can lead to the suspension or revocation of PES contracts. The latter case is not common but can occur in some communities where a significant proportion of community members considers that forest conservation is not in their interest. Overall, it suggests that the relation between TSP and community members is not limited to technical aspects of contract implementation but rather entails considerable efforts of mediation and conciliation between community members and CONAFOR officials but also among community members themselves. Therefore, the role of PES TSP goes often far beyond the

simple definition and implementation of a forest management plan but require to increase collective decision-making and natural resources management capacities.

Most of the TSP interviewed stated that one of the major challenge they have faced is of cultural order. Indeed, many TSP consider that community members expect a paternalistic form of incentives, mostly consisting in unconditional governmental subsidies perceived as deserved. Indeed, in the social representation of many community members, it is the duty of the government to improve the livelihoods of community members. In that context, it is considerably difficult to motivate community members to comply PES contract terms because they consider that the PES money should be focused on helping the livelihoods of community members.

As nearly all TSP are not permanently present in the communities during all contract length, TSP always work in collaboration with one of several community members acting as coordinator. This or these community members can be the elected leader of the community, or any community members chosen by participant community members. Coordinators and TSP communicate per telephone when activities have to be programmed, or to prepare visits from CONAFOR officials. Coordinators have a fundamental importance, because PES implementation is often relatively conflictual at community levels. Annual payment can notably be delayed during some weeks, which irritate many community members fearing that they will not be paid, or some rumors can be disseminated in relation with attempts to deprive PES participants from the land their own.

Nevertheless, the relatively close relationship between TSP and these coordinators generally imply that other community members are often poorly represented in decisions related to PES. Many TSP consider that it is a common phenomenon because many community members are relative shy to express themselves in meetings involving external actors. Overall, many

community members are considered as lacking management skills and therefore the majority of community members do not actively participate to the design of PES programs.

4.4 Discussion

The empirical results have explored how PES procedural rules shape the activities of TSP but also that community contexts also determine the relation between TSP and community members. Based on the description of different profiles of TSP in the state of Chiapas, the results can be mobilized to argue that some, but not all, TSP can cope with uncertainties regarding the evolution of governmental strategy if these TSP have their own intervention strategy relatively independent of PES funding. Consequently, results highlight that organizational capacities, mainly related to the ability to define a long-term intervention strategy, are critical to shape PES implementation at community level. As well, in most of the cases, PES appears insufficient to transform local institutions, but TSP can eventually overcome PES limits and articulate PES with broader intervention strategy.

Many conservation programs based on incentives are complex and need the contribution of external experts at various phases of policy design and implementation (Landell-Mills and Porras 2002; Bosselmann and Lund 2013; Bennett et al. 2014). It appears particularly true in developing countries where the level of trust between governmental agencies and forest managers is sometimes weak and when state officials do not have the managerial, financial and technical skills required to translate PES requirements into grounded practices at community level (Landell-Mills and Porras 2002). Technical assistance is generally provided by third parties like NGO´s, local governmental institutions or independent consultants. TSP are in charge of fulfilling a range of functions, usually enabled by the institutional framework regulating the PES program or in response to the specific need in the context of implementation (Matzdorf, Sattler, and Engel 2013; Swallow et al. 2009; van Noordwijk et al. 2007).

In some contexts, PES procedural rules contribute to create TSP' activities by explicitly defining their organizational characteristics, the rules shaping their functions and their prerogatives in order to reach the goals targeted by PES programs. In other contexts, TSP are organizations or individuals already active in forest management or conservation before the introduction of PES. In those cases, PES procedural rules regulate their activities and determine what should be the intervention strategies. Typical TSP functions encompass informing the potential beneficiaries about the goals of the program, negotiate transactions between forests managers and governmental agencies, training capacities of forest managers to fulfill conservation goals and also to monitor projects (Bosselmann and Lund 2013; Bennett et al. 2014; Huber-Stearns, Goldstein, and Duke 2013; Coggan et al. 2013).

PES contracts often target the adoption of resource management practices in exchange of monetary or in-kind incentives in order to better align the local provision of environmental services with desired needs at other scale (e.g. national or global) (Ferraro 2008; Muradian 2013). Because there is often a gap between general contract terms and specific implementation contexts, TSP can be in charge of facilitating implementation of programs, while keeping transaction costs low (Coggan, Whitten, and Bennett 2010; Kosoy, Corbera, and Brown 2008; Marshall 2013; Zbinden and Lee 2005).

The potential negative consequence is then the risk that the TSP favors the people with who she/he is already in contact, at the expense of other people who are not connected with any TSP. Bosselmann and Lund (2013) have shown that the ability to include small landowners into the program is linked with the operational costs of the TSP, which is a consequence of the type of activities they are involved into (apart from PES), their previous relations with land-owners, and the overall development history of the area where the TSP works. Indeed, an TSP organization may be able to articulate PES with other services offered to landowners. As a consequence, TSP will be inclined to offer PES contracts to landowners that are already targeted

in their existing provision of services. TSP organizations differ in their ability and willingness to be inclusive. Inclusiveness is conditioned by cost aspects, networks, values and land development history.

However, the influence of TSP is not limited to transaction costs consideration. By definition, TSP can be defined by the relational work they perform. As highlighted by the complexity of intervention at community level, it is critical for TSP to gain trust from community members, persuade and motivate them to comply with their contractual obligation and eventually improving their management capacities beyond what is required by PES programs. The results emphasized that not all TSP have the desire or the capacity to do so, and as a consequence, the long-term effectiveness of PES can be limited is TSP have been unable to improve collective decision-making procedures and fostering capacities to better manage forest resources.

TSP therefore work as a relational bridge between different decision-making levels and facilitate the transactions between them. One of the key functions of TSP is to resolve the eventual misunderstandings and problems related to PES implementation. As many PES mechanisms are based on a voluntary participation submitted to eligible criteria, the TSP can take in charge parts of the costs associated with the selection of potential participants. TSP are also critical to design forest management plan with the technical standards required by governmental agencies (georeferentiation, multi-year monitoring,..).

Technical intermediation has sometimes led to a constitution of small network of experts, when the proponent of the mechanism (e.g. the buyer of ecosystem services) lacks resources and expertise to perform some tasks (Bosselmann and Lund 2013; Bennett et al. 2014). Considering that there is often an “institutional void” between the policy design and its practices in environmental programs, the roles of TSP cannot be reduced to information and technology broker and simple management of the program according to its predefined rules (Bracken and

Oughton 2013). TSP mobilize resources and relationships to reach goals, either merely financial or tied to organization interests.

Results suggest that several TSP can use PES to fulfill their own agenda. International, national and local environmental NGOs can influence decision-makers to adopt such mechanism by setting the environmental agenda and favoring the adoption of some instruments at the expense of others (Büscher, Dressler, and Fletcher 2014; Matulis 2013). Such position can help them to capture an important proportion of monetary or prestige benefits associated with the programs, as highlighted by the literature critical on participative approaches (Lund 2015; Mosse 2004; Walker et al. 2007). Indeed, TSP could benefit from an informational rent because they have important power to strategically use their knowledge and expertise to advance their interests.

However, the interests of TSP are not necessarily negative e.g. if they complement a lack of governmental commitment or abilities to foster better management of natural resources (Rathwell and Peterson 2012; Speelman et al. 2014). Some TSP can for example have leadership skills or organizational vision that contribute to advance toward a long-term goal in a context of uncertainty and/or lack of consensus in the definition of goals and strategies between different stakeholders (Mann and Absher 2014; Paavola, Gouldson, and Kluvánková-Oravská 2009; Vignola, McDaniels, and Scholz 2013).

4.5 Summary

This chapter has explored the influence of TSP over PES implementation outcomes in the state of Chiapas. Results have shown that TSP have occupied an increasingly important role in PES implementation and that they are key actors in adapting complex evolving PES procedural rules to community contexts. TSP must notably fulfill several activities such as training community members, designing forest management plan and monitoring the implementation of conservation activities. The interventions of TSP are regulated by CONAFOR in order to

restrict the number of technicians to individuals and organizations holding sufficient skills to operate under evolving PES procedural rules.

The analysis highlighted that not all TSP have the same organizational capacities, so some TSP are better able to overcome the perceived limits of PES by articulating such programs with broader intervention strategy at community but also supra-community levels. There are diverse profiles of TSP, and notable differences exist in relation with their perceptions of PES limits and how they overcome these limits. While independent TSP often only have the capacity to train and monitor communities' conservation activities on a punctual basis, more structured TSP can interact with communities' members on a more regular basis. More regular presence can contribute to transform community institutions not only by changing conservation practices but also by motivating a reorganization of communities' decision-making procedures and disseminating new sources of incomes.

The following chapter analyses the implementation of PES in a community supervised by an independent technical assistant. It describes the challenges associated with the creation of forest management institutions when community members do not consider that forest management is included in the domain of collective action. Nevertheless, the role of community leaders in setting and managing autonomous groups of autonomous community members illustrates the lack of access to decision-making for many community members. In turn, PES programs aggravate power imbalance and conflicts at community level.

5. Unveiling individual preferences for PES contract terms[8]

This chapter relies on a Choice Experiment to answer the fourth research question "What contract characteristics increase the willingness of individual community members to participate to a collective PES contract?". This chapter contributes to explore the challenges associated with participation in collective PES contracts notably when participants are reluctant to engage in collective activities. Considering possible future evolutions in contract design, the Choice Experiment explores individuals' preferences over contract characteristics including who is involved in deciding the parcels to be included in the contract, the type of technical intermediary, the level of payment and the type of incentive (either in individual cash payments or in collective investments). Results reveals strong individual preferences for payments in cash, even when the amount of monetary compensation is lower than in the existing PES contract. An analysis of preference heterogeneity suggests that community leaders play a key role in moderating individual preferences and enhancing participation structured around working groups.

The analysis is performed with a group of 82 community forest owners who are receiving a payment for providing biodiversity-related ecosystem services in the *ejido* of Flor de Cacao (FdC). Section 6.1 presents the Choice Experiment design. Section 6.2 describes the results and section 6.3 discusses them.

5.1 Designing a Choice Experiment to unveil preferences for PES contract terms

Scholars have been increasingly interested in understanding the local conditions that might contribute to increase or decrease the participation in and compliance with PES conditionality (Ferraro 2008; Corbera, Soberanis, and Brown 2009; Brouwer, Tesfaye, and Pauw 2011; Sattler

[8] This chapter is based on Costedoat et al. (2016).

et al. 2013). In doing so, techniques for economic valuation and for understanding local motivations to conserve can be useful tools to investigate what conditions will aid PES design to better fit with heterogeneous implementation contexts and to promote adaptive resource and policy management (Whittington and Pagiola 2012; Westgate, Likens, and Lindenmayer 2013; Gsottbauer, Logar, and van den Bergh 2015). Exploring individual preferences through a choice experiment (CE) is one of these techniques, since it allows eliciting people's interests and values as stated in choice situations (see e.g. Hoyos, 2010 for a literature review on environmental valuation using CE). The following subsection introduces the CE methodology. Section 7.1.2 justifies the choice attributes and the attributes levels used in the CE. Section 7.1.3 presents the statistical design of the CE and section 7.1.4 describes the econometric framework used to assess contract preferences.

5.1.1 Introducing the CE methodology

In a choice experiment focused on designing conservation policies with potential participants, people are asked to select the options they prefer between different hypothetical contracts regarding the provision of environmental goods and services of interest. Contract characteristics are organized around several themes (or "attributes" in CE terminology), which describe the content of the proposed contract. Each contract is then composed of specific values for each theme. These values ("levels" in CE terminology) are categories defined by the researcher and represent possible variations of characteristics around the same theme. The experiment generally consists in making the respondent state the preferred combination of attributes and levels among various combinations presented. Generally, a specific theme can be the level and type of compensation for the good or service that is supposed to be delivered. In that case, each hypothetical contract would include, among other characteristics, a unique value corresponding to the proposed monetary compensation. After the data have been collected, statistical choice models are used to analyze responses so that the researcher can determine which are the levels

preferred by the respondents and eventually express them in monetary terms in order to measure the Willingness To Accept (WTA) or compensation required to deliver goods or services included in each contract.

Until now, there have been several choice experiments to investigate potential designs of PES contracts in both developed and developing countries (Horne 2006; Putten et al. 2011; Broch and Vedel 2012; Dickinson et al. 2012; Kaczan, Swallow, and Adamowicz 2013; Cranford and Mourato 2014; Greiner, Bliemer, and Ballweg 2014; Vedel, Jacobsen, and Thorsen 2015). These studies assess how the required compensation or WTA is affected by the categories proposed in the hypothetical contract. Choice experiment studies related to PES programs in Mexico are scarce, especially if considering the heterogeneity of implementation contexts all over the country. Balderas Torres et al. (2013) show that landowners from the northern state of Jalisco are likely to be interested in joining a PES contract focused on forest conservation and specifically that they prefer short contracts (of five years) with a renewal option than longer ones (of 9 or 17 years). Besides, the probability to participate increases and the required monetary compensation decreases if PES programs are accompanied by health and education projects, or employment and productive projects. In another choice experiment analysing the desirability of a reforestation PES for people already participating in a PES contract in the southern state of Campeche, (Bouma et al. 2014) show that farmers prefer medium to longer term contracts (5 or 10 years) rather than short contracts (2 years). They also highlight that monetary compensation is much lower when farmers reforest 30% of the land allocated under the contract, instead of reforesting 60% of such land or conserving it "untouched". Nevertheless, contrary to the study in Jalisco, people appear to be less prone to allocating part of their monetary compensation to the community, and would require additional compensation if they have to share part of the payment with their community members. This contradiction confirms that the level of compensation required is tied to social and governance characteristics

that can favor or deter preference for local public goods over monetary payments, and individual over collective action (Chhatre and Agrawal 2009).

5.1.2 Choice experiment design and data collection

In Flor de Cacao, the first villagers to join the PES program in 2011 were a group of 60 *ejidatarios* who held secure land titles. This first group was keen to get involved in the PES program, while other *ejidatarios* mistrusted the program because they thought that it would lead to the expropriation of their agricultural and forest lands by the government. Therefore, this first group of *ejidatarios* constituted a working group (*grupo de trabajo*) and got the permission of the assembly to apply and get involved in the program, since the 1820 hectares of forested lands to be targeted were exclusively located on the applicants' own plots. The working group, in turn, elected leaders entitled to collect PES money and perform administrative actions on behalf of group members. The group as a moral person signed the contract with CONAFOR but each member had to demonstrate they formally owned the forests targeted by the contract. Monetary compensation was granted on an individual basis and in proportion to the area included in the program through a flat payment by hectare (550 MXN per hectare). In 2011, CONAFOR allowed them to reclassify their PES contract in the REDD+ Special PES program to raise the payment level (an additional 450 MXN per hectare) while also increasing the forest management plan requirements.

In 2013, a second group of 90 people joined the REDD+ Special PES program through an additional collective contract covering 630 hectares of forests. The group involved landowners with formal property rights who did not trust, ignored or were not aware of the first group's application. Consequently, in this second group, *ejidatarios* who were not members of the first group could choose to pool their forest parcels under the collective contract. In this second group, group leaders agreed to re-distribute the payment between group members to increase the minimum amount of money that small landowners could receive every year, i.e. larger

landowners would receive less money than if they had joined the first group. Another particularity of this second group was related to recent changes in the federal program's operational rules: 40% of the annual collective payment had to be re-allocated to forest conservation activities defined in the forest management plan. At the time the choice experiment has been conducted, participants had just received the first payment and such allocation had not yet been decided.

In *Flor de Cacao*, there are still some villagers who do not belong to any of these two groups. There are formal landowners with forested land plots who are not involved in the program because they did not have time to register to any of the existing groups, are still afraid of getting their lands expropriated or are just not interested in the program's objectives, particularly if they are involved in deforestation activities. Other villagers are unable to participate because they do not have property titles or standing forest parcels.

Fieldwork for the CE was conducted in four consecutive weeks from November through December 2014. The same questionnaire has been used for both groups and only asked the year of first payment received to make the distinction between the two groups: "group A" refers to people receiving PES since 2011 while "group B" designs the people who only entered the program in 2013. The questionnaire was initially tested with group A leaders and with one member of the *ejido* authority because they trusted the research process and were enthusiastic to respond. This first step allowed the community to gain confidence on the research protocol. Subsequently, the questionnaire was administered to voluntary respondents and the final sample contains 82 complete questionnaires (73 male and 9 female PES participants).

The choice attributes were chosen in order to test the legitimacy of key PES operational rules when compared to alternative designs. Attributes and their correspondent levels have been defined by considering available literature on Mexico's PES program and its rules of operation, two visits to the village prior to questionnaire implementation, and a number of informal

discussions with CONAFOR officials and technical service providers. For all attributes, one of the possible levels corresponds to the level of the existing PES contract at the moment the CE was implemented. The cards used in the experiment did not contain a level labelled as *status quo*, because such label would tend to make risk-averse respondents to prefer the contract that is most similar to their current contract, instead of one of the hypothetical alternatives. The selected attributes are presented below:

Attribute 1 (DECI): Decision regarding spatial location of forest parcels included in the program

The first attribute is related to who decide about the spatial location of forest parcels to be included in the PES program. In *ejidos*, such a decision is generally made by the assembly but, as shown earlier, a group of individuals can also get organised and apply to the program collectively while registering on an individual basis (i.e. group A). Group organization is recognized by the program rules of operation and is often adopted in community forestry projects (Wilshusen 2009). The first level defined for this attribute refers then to an exclusively individual decision, i.e. all forest owners can decide individually to participate or not and allocate as much of their forests as desired under the program, without referring to their peers. The second level reflects the program's implementation as stated by the rules of operation at the time of the study, i.e. the forest parcels to be included have to be discussed and approved by the assembly. This means that the total conserved area is decided collectively, and individuals who want to include more (or less) of their forest parcels would have to respect the assembly decision. The third level aims at representing a situation in which all forests of the *ejido*, regardless of their tenure condition (privately or commonly owned), are included in the program.

Attribute 2 (TESP): Technical service provider

To submit the PES application, communities and *ejidos* require the support of a technical service provider, which can be an NGO or an independent consultant. Therefore, the first attribute level represents an external service provider. Because this idea was not clearly understood by respondents when the questionnaire was tested, this level is reframed to explicitly refers to their current service provider, which can include a bias in the results if there is a preference for the present *status quo*. The second attribute level proposes that technicians come from the community after they are duly trained. The third attribute level represents a situation in which CONAFOR officials become the technical service provider.

Attribute 3 (PAYM): Payment level

The third attribute is the amount of compensation received by a landowner. Four payment levels are proposed, i.e.: 250, 500, 1000 and 2000 MXN per hectare per year. These levels are close to the payment range chosen by CONAFOR across the country's PES eligible areas in 2014 (CONAFOR has defined 6 areas with differentiated payment ranging from 280 to 1100 MXN per hectare per year depending on the type of ecosystem and the risk of deforestation). The level of 2000 MXN is added an upper value, which would double the payment level of the REDD+ Special PES program defined in the procedural rules when the CE was implemented, in order to assess the impact of a substantially higher payment on the other attributes.

Attribute 4 (USEP): Use of payment

The fourth and final attribute is related to the use of the payment. In the case of collective contracts, participants decide upon the distribution of benefits: they can share the payments between landowners, share it with other members, or invest it in local public goods(Alix-Garcia et al. 2005; Muñoz-Piña et al. 2008)(Alix-Garcia et al. 2005; Muñoz-Piña et al. 2008). Since 2013, CONAFOR requires that at least 40% of the payment received is directly spent on conservation activities as defined in the application's accompanying management plan, while

participants can freely split the rest. In this context, three possible payment use options are proposed. The first level involves cash rewards only, delivered according to the decision-making procedure chosen for attribute 1. The second level involves payments that are evenly distributed (50%/50%) between cash and a social project aimed at improving the community's wellbeing (e.g., school, clinic, or maintaining infrastructure such as public lights or roads). Such community public goods are usually funded either by governmental subsidies or by community contribution. The third level involves payments delivered both in cash (50%) and in the form of bank savings (50%), the latter of which would be used to buy some tractors for those participants that have complied with contract terms after a five-year period. In a context of subsistence agriculture, villagers rarely have access to credit. Facilitating access to mechanization could lead to intensification of agricultural practices and contribute to improve livelihoods . Choice attributes and their respective levels are summarized in Table 8.

Table 8. Attributes and attribute levels used in the choice experiment

Attribute	Levels	Ranking
Forest parcels	Individual decision Negotiated by the community assembly All forests of the *ejido*	1 2 3
Technical intermediary	External service provider Community technician CONAFOR	1 2 3
Payment per hectare (MXN)	250 500 1000 2000	1 2 3 4
Use of payment	100% cash 50% cash + 50% collective agricultural productive project (tractors) 50% cash + 50% social project (community public good)	1 2 3

Note. The ranking corresponds to the expected order of preferences for each attribute (1 being the expected preferred level). This ranking is used to generate a D-efficient statistical design.

5.1.3 Statistical design and presentation of choice cards

Including all possible contracts in the design (3*3*4*3=108 hypothetical contracts) would make respondents choose their preferred contract among all hypothetical contracts. It is not

realistic to present all these alternatives to respondents and impossible to test all the trade-offs when the sample of respondents is limited. Therefore, a more sensible option was to use an efficient design. Such design consisted in optimizing the number of hypothetical contracts by considering only a limited number of them without losing information on the trade-offs between attributes (Hoyos 2010). Hypothetical contracts are obtained through a D-efficient statistical design using NGENE software version 1.1.1.[9]

D-efficient designs require that the researcher defines priors for each attribute level. Since the sampled population did not allow for a pilot study to obtain these priors, the expected ranking of attribute levels is defined by the researcher and is presented in Table 8. Based on discussion with CONAFOR officials and initial understanding of the local context, respondents would prefer individual decision (rank 1) to community decisions (rank 2) and would tend to dislike the fact of being forced to include all forests in the program (rank 3). Regarding the intermediary, most respondents were satisfied with their intermediary (rank 1). Community technician might be also an option that they would like (rank 2) but one can expect that they dislike the presence of CONAFOR (rank 3). Finally, for the use of payment, 100% in cash is likely to be preferred (rank 1) over productive projects (rank 2), while social projects would be disliked (rank 3). It is important to note that these ranking expectations were only used to generate the design of the choice cards and aimed at limiting the risk that some combinations would have been systematically preferred by respondents.

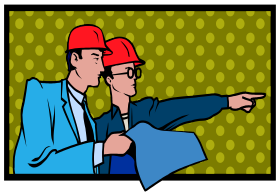
A large number of choice cards would be complicated to administer in the targeted sample, so the total number of choice cards is divided among different versions. Based on the implementation of a similar version of the survey (Bouma et al. 2014), six choice cards

[9] A D-efficient design is an efficient design which minimize the so-called D-error (determinant of the inverse of the variance–covariance matrix of the list of contract presented) in order to produce the design with minimized errors around the measure of attributes (Hensher 2005, 152–53; Rose and Bliemer 2009).

appeared reasonable in the context of rural Mexico. The statistical design consisted of 18 choice cards divided between 3 survey versions of 6 choice cards each (see Annex 3Annex 3. Choice cards used in chapter to see the composition of the 18 choice cards). By randomly assigning survey versions to respondents, various trade-offs between the levels that are believed to be relevant to assess individual preferences can be tested. After a short introduction and an example used for illustration, the six choice cards were shown and landowners were asked to select their most preferred option for each card.

Each choice card contained three alternatives, i.e., an alternative with no land use restrictions and no monetary compensation, and two alternatives with varying levels of land use restrictions, type of technical intermediary, compensation level and use of the compensation. An example choice card is shown in Figure 10.

Figure 10. Example of a choice card as presented to respondents

	Contract 1: You are not allowed to cut down trees on parts of your land	Contract 2: You are not allowed to cut down trees on parts of your land	No contract
Who decides which part of the forest is restricted?	Entire forest 	Individual decision 	You are allowed to cut down trees on your land You will not receive an annual monetary compensation
Technical intermediary	External service provider 	Community technician 	
	500 MXN/ha per year	250 MXN/ha per year	

Monetary compensation				
Distribution of monetary compensation	Cash 100%	Cash 50%	Productive project 50%	
Your choice	☐	☐		☐

Note. This card is the English translation of choice card 1 of survey version 1 (Annex 3)

5.1.4 Econometric framework

The probability for an individual to choose a contract is the result of complex interactions between individual characteristics (e.g. psychological, economic and social factors) and the characteristics of the contract. In microeconomic theory of consumer behaviour, an individual will choose a particular contract if the characteristics of this contract provides him a satisfaction expressed in the form of utility (Louviere, Hensher, and Swait 2000, 2–7). Therefore, the preferred contract (i.e. the one that generates the highest utility to the individual) has the highest probability of being chosen. This probability can be derived from an indirect utility function defined according to Random Utility Theory (McFadden 1974; Louviere, Hensher, and Swait 2000, 37–44; Hensher 2005, 82–86). Following this theory, the (unobserved) utility of a contract c for an individual i as $U_i(c)$ has two components: a set of observable contract characteristics $Z(c)$ that influence the decision, and a non-observable component $\varepsilon_i(c)$ corresponding to variations in individual choice.[10] The associated utility function can be written as follows: $U_i(c) = \beta_i * Z(c) + \varepsilon_i(c)$ (1)

[10] The non-observable component takes into account all of the unobserved sources that influence utility so it is specific for each individual and each alternative. As one cannot observe its distribution, it is assumed that the

In this formula, $Z(c)$ is composed of the contract attributes defined earlier. Therefore, utility derived from a contract is the sum of the utilities of each contract attribute. This means that:

$$U_i(c) = \beta_i^{ASC} + \beta_i^{DECI} * DECI(c) + \beta_i^{TESP} * TESP(c) + \beta_i^{PAYM} * PAYM(c) + \beta_i^{USEP} * USEP(c) + \varepsilon_i(c) \qquad (2)$$

β_i^{ASC} is called the alternative-specific constant (ASC) and takes into account the preference for the no-contract option. The values of the vector of parameters β (i.e. $\beta_i^{DECI}, \beta_i^{TESP}, \beta_i^{PAYM}$ and β_i^{USEP}) corresponds to the individual marginal utilities for each attribute and attribute level. Assessing the values of these parameters requires to estimate the probability that an individual chooses a specific proposed contract, i.e. the probability that this contract is preferred to other contracts in the choice card. The distribution of the probability has to be chosen by the researcher given the assumptions that can be made about the preferences of individuals in the sample.

In the literature, one of the standard choice models is the Multinomial Logit Model (MNL) (McFadden, 1974; Louviere et al., 2000, pp. 44–47). In that model, under the condition that the random components ε_i are identically and independently distributed following a Gumbel distribution, the probability that an individual *i* chooses contract *c* among a set of alternative contracts *K* is given by the ratio of the exponential of the sum of marginal utilities of contract attributes over the sum of exponential of the sum of marginal utilities of all available contracts *K*:

$$Prob_i^{MNL}(c|K) = \frac{e^{\beta * Z(c)}}{\sum_{k=1}^{K} e^{\beta * Z(k)}} \text{ for all } c \in K \quad (3)$$

component is independently and identically distributed (IID) across alternative and individuals (Hensher 2005, 74–82). In choice analysis, the assumed distribution of the non-observed component is generally a type 1 extreme value, also known as Gumbel distribution.

The advantage of this model is the simplicity of its interpretation because it produces only one estimate for each choice attribute or choice attribute level ($\beta^{ASC}, \beta^{DECI}, \beta^{TESP}, \beta^{PAYM}$ and β^{USEP} represent average sample preferences), i.e. it assumes that individual preferences are homogeneous across all respondents.

However, the assumption that all individuals have the same marginal utilities for each attribute or attribute level rarely holds in reality. The Latent Class (LC) model is able to deal with heterogeneous preferences by considering that individual preferences can be classified in a defined number of separate segments (Boxall and Adamowicz 2002; Greene and Hensher 2003).[11] In that case, the values of β can vary from one segment to another, i.e. β^{ASC}, β^{DECI}, β^{TSP}, β^{PAYM} and β^{USEP} may have a unique estimate for each segment, corresponding to respective segment averages. In other words, the LC model can classify preferences of individuals by assuming that individuals can be grouped in segments of respondents with similar preferences. It is important to note that the identification of segments and the eventual variables chosen to predict the probability for an individual to belong to one or other segments are estimated separately. It means that the set of variables does not have an influence on the identification of the segments. Therefore, in the LC model, the probability that an individual *i* chooses contract *c* from a set of contracts *K*, is equal to the sum of probabilities that an individual in segment s chooses contract *c* among *K* alternative contracts, weighted by the probability $Prob_i(s)$ that this individual belongs to segment *s* among *S* segments [12] :

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[11] As noted by Boxall and Adamowicz (2002), one could consider the MNL as a particular case of the LC model where there is only one segment. Another case would be to consider that each individual is a segment, which corresponds to a Random Parameters Logit (RPL) model. RPL results are not presented here because this model requires additional assumptions regarding the distributions of β. More importantly, the interpretation of RPL results is limited to showing the existence of heterogeneity without explaining its potential sources.

[12] Assuming that individual segment membership M_{is} can be explained by the sum of an observable combination between a coefficients of segment-specific coefficients A_s associated with a set of socio-economic variables X_i and an unobservable component ζ_{is},, the class membership function is defined as as $M_i(s)=A(s)*Z_i+\zeta_{is}$ (5) so that $Prob_i(s) = \frac{e^{A(s)*X_i}}{\sum_{s=1}^{S} e^{A(s)*X_i}}$ (6) (Boxall and Adamowicz 2002).

$$Prob_i^{LC}(c, s|K, S) = \sum_{s=1}^{S} \left(Prob_i(s) * \left[\frac{e^{\gamma_s * Z(c)}}{\sum_{k=1}^{K} e^{\gamma_s * Z(k)}} \right] \right) \text{ for all } c \in K \text{ and for all s} \in S \qquad (4)$$

The estimation procedure consists of computing respectively equations 3 and 4 using the choice data in order to obtain the corresponding estimates of β with the software NLOGIT version 4.0. Estimation is performed through a Maximum Likelihood Estimation (MLE) procedure, which is an iterative procedure that maximize the likelihood that the estimates of β correspond to the choices made by individuals given respective contract characteristics (Louviere, Hensher, and Swait 2000, 47–51; Hensher 2005, 317–23). By construction, the monetary compensation required for each non-monetary attribute (all the parameters except β^{PAYM}) is obtained by dividing the opposite of their respective estimates by the estimate of β^{PAYM}. Furthermore, by replacing the estimates obtained for the parameters β in equations 3 and 4, one can calculate logistic choice probabilities $\hat{\pi}(x)$ associated with specific contracts defined by the researcher (see section 3.3).[13]

5.2 Results

5.2.1 Descriptive statistics

From the collected 91 questionnaires only 87 were complete. From this set, five respondents who owned forests but were not able or willing to participate in the PES programs have been discarded, resulting in a sample of 82 respondents used for data analysis. The final and representative sample included 28 members of group A and 54 members of group B, which represent a coverage of 46.6% and 60%, respectively. Respondents' key characteristics are presented in Table 9. Most program participants are male because they mostly include formal landowners (*ejidatarios*), who have traditionally been male. The two groups differ in terms of

[13] $\hat{\pi}(x) = \frac{e^{\hat{g}(x)}}{1+e^{\hat{g}(x)}}$ (7) where $\hat{g}(x)$is the estimated logit of a specific vector of preferences *x* (Hosmer and Lemeshow 2000).

some observable characteristics. For example, group A is composed of older people with larger land plots (in particular larger forested areas), includes a higher proportion of literate people and who have more often been elected in a management position in the community (annual or tri-annual mandates after being elected by the assembly of *ejidatarios*). Besides, they generally have more backyard animals, have more mobile phone access, and are more able to receive agricultural subsidies than members of group B. Members of group A also tend to think that the payment distribution in the existing PES program is fair and that the program is positive for the community. Overall, these differences suggest that group A is composed of better-off people who have easier access to decision-making than group B. Still, both groups consider that the impact of the program is positive, show a low level of trust in community authorities and are concerned about their low income levels, which makes it difficult for them to prosper (40% overall). Herd size does not seem to influence membership across groups, so group membership is not explained only by a difference between livestock and agricultural activities.

Table 9. Background characteristics of the surveyed respondents

Variable	Total (N=82) Mean (SD)	Group A (N=28) Mean (SD)	Group B (N=54) Mean (SD)	t-test of group differences
Male (D): 1 if male; 0 if female	0.9 (0.3)	0.9 (0.3)	0.9 (0.3)	
Age	41.3 (11.9)	45.4 (9.7)	39.2 (12.4)	**
Household size	6.2 (2.5)	6.1 (2.6)	6.2 (2.5)	
Knows how to read (D)	0.8 (0.4)	1 (0.3)	0.7 (0.4)	**
Plot size (ha)	34.4 (18.8)	44.3 (18.2)	29.3 (17)	***
Forest plot size (ha)	21.9 (12.2)	30.2 (11.6)	17.6 (10.1)	***
Number of cows	5.9 (16.7)	5.9 (11.8)	5.9 (18.8)	
Has a cellphone (D)	0.6 (0.5)	0.8 (0.4)	0.5 (0.5)	**
Considers income as sufficient (D)	0.4 (0.5)	0.3 (0.5)	0.5 (0.5)	
Has been elected to a management position in the community (D)	0.2 (0.4)	0.4 (0.5)	0.2 (0.4)	**
Has trust in hers/his peers (D)	0.4 (0.5)	0.4 (0.5)	0.4 (0.5)	
Receives agricultural subsidies (D)	0.6 (0.5)	0.8 (0.4)	0.5 (0.5)	**
Considers the distribution of payment is fair (D)	0.5 (0.5)	0.7 (0.5)	0.5 (0.5)	*

Thinks the payment has a positive impact on her/his household (D)	0.8 (0.4)	0.8 (0.4)	0.8 (0.4)	
Thinks the payment has a positive impact on the *ejido* (D)	0.7 (0.1)	0.8 (0.4)	0.6 (0.5)	*

Note. D: binary variable. If no values are specified, the variable takes the value 1 if the statement is affirmative, 0 otherwise. SD: standard deviation. t-test of difference checks if there is difference in means between group A and group B for each variable. ***, **, * = statistical significance at 1%, 5% and 10%, respectively.

5.2.2 Explaining heterogeneity of preferences

Since group A is composed of a larger proportion of people who are better off and have better access to elected positions, they probably feel that entering the program is less risky, in comparison with participants from group B. Additionally, as members of group A own significantly larger lands and forested areas, their opportunity cost of conserving forest should be lower than for people in group B. Given these findings, belonging to one group or the other implies a significantly different pattern of preferences for contract characteristics. In the model, factors such as socio-economic variables are used as opportunity cost proxies (amount of cattle owned and individual forest size). Whether people have been previously elected to a management position is believed to constituted a proxy for attitudes toward risk and leadership skills and could explain divergences of preferences between individual and collective perception of a contract. Therefore, next to estimating a MNL model, a LC model with two segments is also estimated, where the four mentioned variables are used as explanatory variables for belonging to one of the two segments.

Table 10 shows the results of the MNL model and the LC model with two segments. Table 11 describes model statistics, which show that the LC model with two segments is justified for this dataset. Although the statistical properties of the estimation and the signs of coefficients appear coherent, results are analysed with caution due to the relative complexity of the model for a limited sample size.

Table 10. Model statistics

No of segments	No of parameters (*P*)	Log Likelihood function (LL)	Restricted LL (RLL)	Adjusted McFadden's pseudo-R^2	AIC	BIC
MNL model						
1	8	-460.12	-531.73	0.12	1.9	1.97
LC model without variables explaining class membership						
2	17	-390.56	-540.5	0.25	1.66	1.8
3	26	-380.40	-540.5	0.25	1.65	1.87
LC model with variables explaining class membership						
2	21	-387.26	-540.5	0.25	1.66	1.84

Note. All models are estimated with N=492 observations, which correspond to six choices for each of the 82 respondents. LL is the natural logarithm of the likelihood function and corresponds to the value of the function that maximizes the likelihood of the parameters estimated. The value is always negative and the closer the value is to zero, the better the model fits the data. Restricted LL corresponds to the natural logarithm of the utility function in the case of a model composed uniquely of constants. Adjusted McFadden pseudo-R^2 is a statistic used to determine model fit and is calculated by 1-[(LL-P)/RLL)]. Information criteria are used to determine which model better fits the data. Following Boxall and Adamowicz (2002), Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) are used to choose a model that has the higher likelihood with a minimum number of segments. AIC is the Akaike Information Criterion obtained by [-2(LL-P)]/N; BIC is the Bayesian Information Criterion: [-2*LL+P∗ln(N)]/N. While the model with two segments minimizes the BI criterion, the model with three segments minimizes AI criterion. Nevertheless, the model with three segments identifies a class with a non-significant probability and extreme values for parameters. Moreover, including class probability function to the model with three segments, NLOGIT 4.0 is not able to calculate the values for coefficients, probably do to the fact that the software is not able to take into account the important numbers of parameters. Therefore, the model with two segments is preferred.

Results show that plot size, group membership and cattle numbers are not significant in explaining the differences between segments. Instead, the fact of having been elected is the only significant variable and the robustness of this finding is confirmed by testing different combinations of class membership variables (some of them are presented in Annex 4). Its negative sign indicates that respondents who have exercised a form of responsibility in the *ejido* are more likely to have preferences described by the second segment. Note that contrary to the fact of belonging to a working group, segmentation is not an observable characteristic because segments are only defined statistically.

Regarding the assessment of preferences, the constant represents average preferences to accept the contract according to the reference levels. In the experiment, such levels correspond to

contract features similar to the characteristics of the current PES program, i.e. a contract with the assembly taking decisions about the spatial location of the parcels to be conserved, with an external service provider, and with compensation exclusively in cash. Table 10 shows that the coefficient is statistically insignificant in the MNL model, and that the associated compensation is negligible, which implies that almost no compensation is required for such a contract to be accepted. In other words, considering the entire sample, respondents prefer a PES contract to a situation without any contract, even if the offered compensation is small.

In the LC model, the constant is negative in the first segment and positive in the second, and both are statistically significant. The pattern of preferences in segment 1 therefore corresponds to a contract refusal if the attributes are at reference levels, while the pattern in segment 2 describes a preference for having a contract, regardless of the compensation level. Consequently, the PES payment at reference level is strongly positive for segment 1 (900 MXN) and negative for segment 2 (-1229 MXN), which means that this latter pattern of preferences consists in accepting a PES contract for far less money than in segment 1. Predicted compensation levels also show that on average, respondents prefer to decide at an individual level what forest should be included in the program, compared to deciding it collectively in the assembly. This preference for individual decision is also significant in the second segment. As well, no significant preferences or aversion for having to put all the community forests in the program are observed, as compared to letting the community decide the location of conserved forests.

Table 11. MNL and LC model estimates and associated compensation values

	MNL		LC (Segment 1)		LC (Segment 2)	
Attributes	B (SE)	Comp.(S	B (SE)	Comp.(S	B (SE)	Comp.(S
Constant (ASC)	0.29 (0.24)	-26 (200)	-1.02 ***	900 ** (379)	2.44 ***	-1229 ***
Forest decision (reference: Assembly decision)						
Indvidual decisión	0.30 * (0.18)	-269 (166)	0.26 (0.19)	-227 (176)	0.67 ***	-338 *** (110)
All forests	-0.04 (0.18)	33 (162)	-0.12 (0.23)	108 (199)	0.13 (0.22)	-68 (113)
Technical intermediary (reference: External provider)						
Own community	-0.05 (0.16)	43 (145)	-0.15 (0.17)	134 (156)	0.62 ** (0.22)	-310 *** (108)
CONAFOR	0.19 (0.15)	–170 (131)	0.26 (0.17)	-234 (148)	-0.06 (0.22)	29 (112)
Payment level						
Level in thousands of MXN	1.11 ***	N/A	1.13 ***	N/A	1.99 ***	N/A
Use of payment (reference: 100% cash)						
50% cash/ 50% social	-0.69 ***	621 *** (177)	-0.34 * (0.19)	299 * (161)	-2.99 ***	1,503 ***
50% cash/ 50% productive	-0.81 ***	732 *** (169)	-0.51 ** (0.26)	450 ** (211)	-3.15 ***	1,587 ***
Class probabilities in % (SE)			69.17*** (2.06)		30.83*** (5.46)	
Class probability function						
Constant			1.51 ** (0.66)			
Group A (D)			0.56 (0.71)			
Plot Size (ha)			-0.01 (0.02)			
Number of cows			0.01 (0.02)			
Has been elected to a management			-1.40 ** (0.68)			
Model statistics						
Number of observations	492		492			
Log likelihood	–460.12		-387.26			
Restricted LogL	–531.73		-540.5			
Adj. Pseudo-R^2	0.12		0.25			

Note: The sample contains 492 observations, which correspond to six choices for each of the 82 respondents. ***, **, * = Statistically significant at 1%, 5% and 10%, respectively. B=coefficient; (SE)=robust clustered standard error; Comp=Associated monetary compensation in MXN/ha; N/A=not applicable.

In the MNL model and in segment 1, having a technical service provider native from the community or from CONAFOR has almost no effect on average preferences, and therefore the impact on the compensation level is very limited. Indeed, the obtained coefficients are not significant in both cases, confirming that an external service provider is the preferred option. However, in segment 2, community technician is preferred to an external one. Finally, there is a clear aversion for compensation that is not 100% in cash. Unexpectedly, both segments would require more monetary compensation if a part of the payment is used in productive investment than if it is used in social investment. In the case of segment 2, a contract with a payment that is not 100% in cash would even be refused.

5.2.3 Simulating the probability to accept a contract

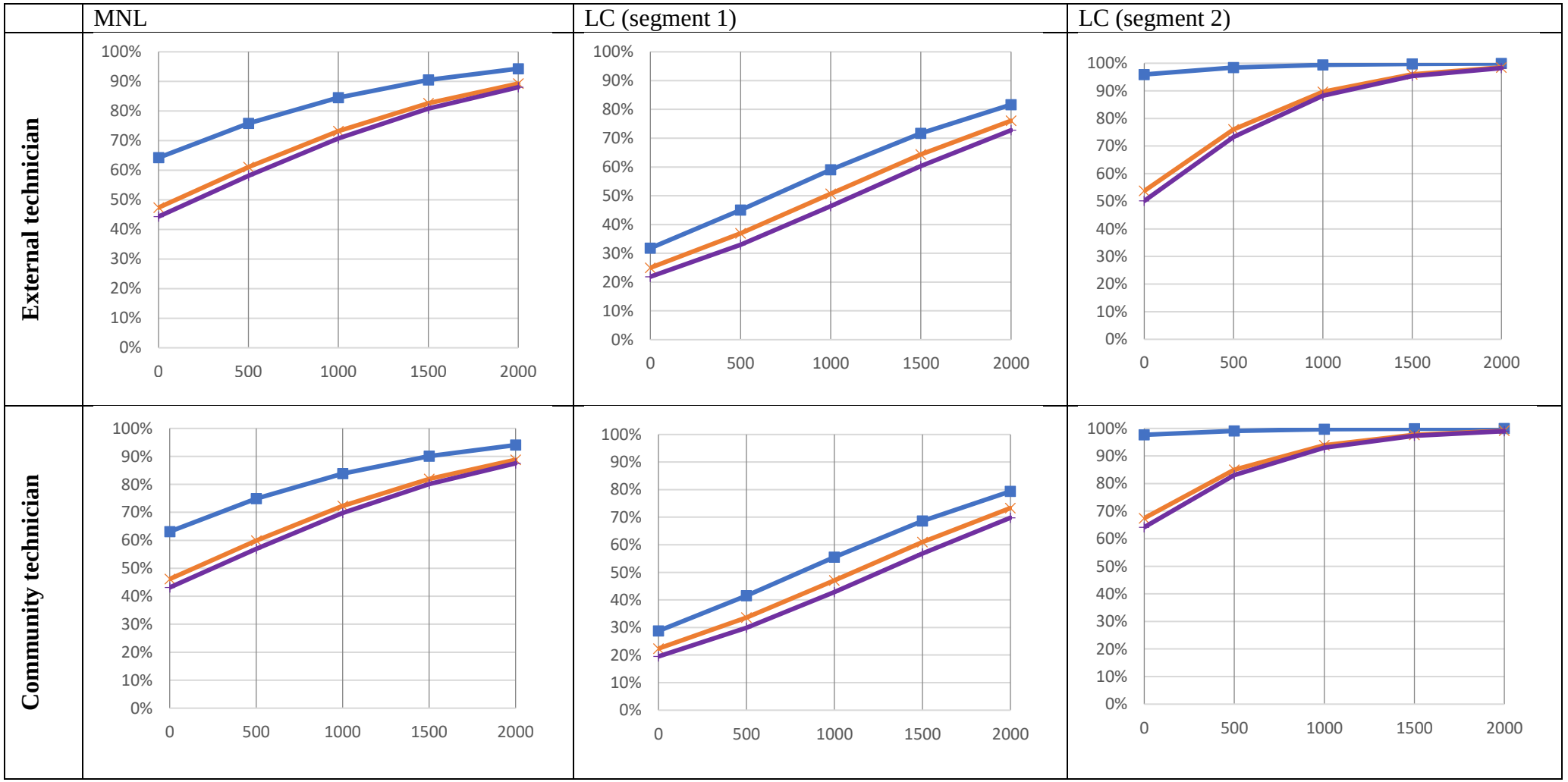
In order to know more precisely how contract characteristics influence the probability to accept a contract, several contract options are simulated using a market share analysis (see for example Koetse and Hoen, 2014). For each contract, the probability of choosing the contract versus not choosing the contract is computed using the estimates in Table 10. The associated table with 95% confidence intervals can be found in Annex 5. The previous analysis has shown that, in the MNL model, people prefer individual contracts, 100% in cash and consider that the external service provider is satisfying. The simulation (Figure 11) tests the sensitivity of the probability to the use of payment (cash, social or productive) as well as the sensitivity to the fact of having either a community technical service provider or an external technician. Simulation results for payments levels of 500, 1000, 1500 and 2000 MXN/ha are presented (in a situation where there

is a conservation contract without any monetary compensation instead of the compensation of 250 MXN).[14]

The probabilities have to be interpreted with caution because they result from extrapolation. However, they compare preferences for different contracts but also differences between the two segments identified in the LC model and the MNL model. For each simulated contract, increasing the payment level increases the probability to accept the contract. It is logical because the estimates for payment level were positive in Table 10. The probability to accept a contract 100% in cash, with compensation of 1000 MXN/ha, individual decisions to involve forest and with an external service provider reach 84,5% when using the MNL estimates. This probability is high and appears to be affected very marginally in average if the community technician option is proposed instead of an external technician, all other contract characteristics being held similar. However, introducing a proportion of the payment in social or productive investments considerably lowers the probability to accept a contract, especially if payment levels are inferior to 1000 MXN for segment 2 of the Latent Class model. There is a substantial gap between the segments for similar contracts: nearly all contracts in cash and all contracts including projects with 1000 MXN or more would be accepted with a very high probability in the pattern of preferences revealed by segment 2 while all contracts are associated with a lower probability of acceptance for segment 1.

[14] By convention, a contract without monetary compensation is a conservation contract of 0 MXN/ha, among other defined characteristics. A contract without monetary compensation can be a way to assess if there is non-pecuniary motivation for conservation.

Figure 11. Estimated probabilities to accept a contract by payment use, payment level and technical service provider



Note. MNL corresponds to average probabilities derived from coefficients estimated with a MNL model; LC segments 1 and 2 corresponds respectively to probabilities derived from coefficients for segment 1 and 2 of the LC model. For each specification, the sensitivity of probability to accept contract when payment is 100% in cash, where payment is 50% in cash and 50% is invested in a social project, and when payment is 50% in cash and 50% is invested in a productive project are presented. The sensitivity to the technical service provider (external or from the community) is also simulated. X-axis expresses the probability to accept the specified contract compared to a situation without contract, Y-axis is the monetary compensation (in MXN). All contracts are simulated for the situation where individuals make decisions regarding the area and spatial location of forest included in the conservation contract.

5.3 Discussion

The findings reflect, first, the relative indifference to community or CONAFOR officials acting as technical service intermediaries. This result suggests that the external service provider is considered as a satisfactory program characteristic. At least, it appears that the respondents have no complaint about the work of the intermediary, and they have no clear preferences for the alternative proposed. Another way of looking at the result considers that it is not possible to identify strong opposition to community service providers, which supports the idea of paying communities to monitor their carbon forest stock themselves, as proposed for REDD+ implementation in Mexico (Skutsch 2012). If the community had already had a concrete example of community service providers, the results would better reflect preferences based on their experiences (Schläpfer and Fischhoff 2012).

The results also highlight people's aversion to invest a share of their payment in social or productive collective projects. Contrary to Balderas Torres et al (2013) but in accordance with (Bouma et al. 2014), respondents in *Flor de Cacao* would require substantially more compensation for payments that are not 100% in cash. The reluctance to participate in a productive project as counter-intuitive because such a project could have the potential to benefit landowners more than collective social projects or cash. This is nevertheless quite in line with the expectations of promoters of direct payments over integrated approaches, who argue that payments have greater potential to catch the short-term interest of landowners (Ferraro and Kiss 2002). Indeed, as the pre-defined productive project entailed the purchase of tractors after a 5-year compliance period, many respondents felt that they would probably not benefit from this. For example, some respondents might not be interested in mechanization practices; others might have perceived a risk of conflict over tractor sharing as an extension of the division between both community PES groups; and

others might have thought that tractors might entail recurrent maintenance costs. In-depth preliminary interviews dedicated to ascertain what can be a relevant productive project in *Flor de Cacao* would probably have led to propose an option more likely to be preferred by respondents. Nevertheless, such interviews would have contributed to associate the interviewers with PES promoters, which would have complicated data collection and would have introduced bias in responses.

It is worth highlighting that preferences for payment in cash and for individual decision-making appear to be coherent with the existing family-owned tenure system prevailing in the studied *ejido*, in which forest commons have never really existed (see chapter 6). This result casts doubt on the local future acceptability of the recent change in CONAFOR's operational rules, which as noted earlier require that 40% of payments be spent on collective conservation activities. Notwithstanding, the analysis also shows that increasing monetary compensation would lead to higher probability of participation levels, which is consistent with CONAFOR's strategy to increase payments in the region to raise participation levels after 2010.

The simulation performed has also shown that the probability to accept a contract at 500 MXN/ha (half the level of payment defined in procedural rules) is quite high (more than 75%). A strategy focused on increasing participation is therefore not necessarily efficient if a significant number of people would have participated even with a low compensation (at least once they have seen that the program does not create a risk of expropriation). Moreover, evidence suggest that PES have led to considerable avoided deforestation in other *ejidos* of the region that are receiving payments since 2008 or 2009, i.e. when the payment was only of 450 MXN/ha (Costedoat et al. 2015)). Consequently, unless deforestation risk has grown since 2010, increasing payment levels to

enhance participation should not necessarily lead to higher average levels of avoided deforestation. This rather strong argument and hypothesis should be further tested empirically.

The analysis also demonstrates the existence of divergence in preferences within collective PES contracts. The lack of unity is evident, as the possibility to join the PES program has not been initially considered by the assembly. In line with existing literature on the willingness to accept a PES contract, respondents' preferences can theoretically be explained by differences in their land opportunity costs and perceived risks of entering the program, both situations being in some cases linked (Zbinden and Lee 2005; Kosoy, Corbera, and Brown 2008; R. A. Arriagada et al. 2009). However, differences in productive practices and associated opportunity costs do not explain preferences' segmentation. The fact that such characteristics could be relatively homogeneous at community level would prevent them from being clear explanatory factors. Different pattern of preferences between segments is not explained by belonging to the group that has entered either in 2011 or in 2013, but rather by having previously exercised an elected responsibility in the *ejido*. Access to a leadership position therefore increases the probability of accepting a PES contract. Such access leads to an increased understanding of the aims of the program, its associated risks, and the benefits from participation (Kosoy, Corbera, and Brown 2008). Therefore, elected members have been more enthusiastic to participate to the program, which can be an explanation for the fact that they are more numerous in the first group of applicants.

It is paradoxical that segment 1 shows a low probability to accept a contract at current levels, because all respondents are currently involved in such a PES contract and indicated that they wished to renew it. In this regard, despite the precautions needed to interpret results derived from a small sample, the segmentation of preferences reveals that *ejido* and groups' leaders have had a moderating role at community level to convince other landowners to participate in the PES

program. Leadership, but also willingness to follow peers' decisions, have not been directly taken into account in this study because the analysis is focused on individual preferences toward contract design. However, organizations such as working groups or the community assembly appear critical to manage the forest and to access both individual and collective subsidies (Ezzine-de-Blas et al. 2009; Rico García-Amado, Ruiz Pérez, and Barrasa García 2013). Future research should try to understand how collective preferences have been formed and if the formation of such preferences can be related to the way working groups have been established, which can be pursued combining CE with methodologies such as social network analysis. Panel data aimed at tracking eventual change of preferences over time and the cause of this change could also provide key insights to understand at which conditions respondents would renew their contract.

In a social context such as a Mexican *ejidos*, which encompass households with distinct tenure and land assets conditions, it is difficult if not impossible to design a contract that would constitute the most preferred option for all landowners. It becomes even more complicated considering regional or national scale. Various choice experiment studies that have revealed heterogeneity of preferences (in particular heterogeneity of required compensation) recommend to propose various levels of payment in order to achieve efficiency gains (Broch and Vedel 2012; Broch et al. 2013; Mulatu, van der Veen, and van Oel 2014). Indeed, allocation mechanisms such as price discrimination and procurement auctions could theoretically be a way to reveal opportunity costs and targeting people with lower WTA levels (Ferraro 2008). It is important to note that these studies are performed at larger scales (national and watershed level) than this study. At community level, the role of leaders in fostering participation could also be a way to make landowners more likely to participate without creating social conflict. Furthermore, the preferences for a contract are not only determined by the level of subsidies, but also by other non-monetary contract

characteristics (Lienhoop and Brouwer 2015). In this case sudy, a contract designed to fit community preferences could be more cost-effective than the PES program as currently devised by CONAFOR. It nevertheless depends on the ability of the communities to understand and adapt program rules to their preferences (Mahanty, Suich, and Tacconi 2013)

The results represented preferences of a significant proportion of PES participants in the studied community. However, it is hard to claim external validity of these results given the diversity of institutional and environmental characteristics of Mexican *ejidos*. However, the results contribute to postulate a relation between contract preferences and land tenure characteristics. More generally, preferences toward participation are driven by individual factors as well as by contextual issues, such as existing rules regarding benefit-sharing that notably shape preferences.

Other attribute levels like payment duration or type of activities to be performed can be found in the literature and several have been tested in the Mexican context (Balderas Torres et al. 2013; Bouma et al. 2014). Furthermore, a limitation of this study derives from the fact that penalties for non-compliance are not added; so it is assumed that individuals make decisions mostly based on their expected gains. Additionally, other subtler segment membership variables could have been included in the analysis. For example, the introduction of georeferenced information at the individual parcel level could have provided better proxies for opportunity costs (e.g. walking distance from the village or soil productivity). Nevertheless, this type of data would have required more time and a deeper level of trust between the interviewers and the farmers. More precise information about community members' social relationships, trust levels and motivations could have also been incorporated to provide a more nuanced understanding of benefit-sharing preferences. Some of the responses, especially those related to the choice of the technical intermediary, can be biased, because respondents might have mistakenly associated the

interviewers with CONAFOR or the external service provider. Also, interviewers may have been viewed as being involved in other activities than research and some respondents could have thought that the questionnaire served another purpose than the one stated by the interviewers.

Another limitation of this study is related to the possible confusion between the decision to incorporate forests into the program and the type of payment. Indeed, if respondents have clear preferences for individual contracts, it is difficult to ask them to choose to invest part of the payment into social or productive collective projects. Nevertheless, it is not necessarily a contradiction. In the community, PES participants have to participate in frequent collective (unpaid) conservation tasks, while they receive annual individual payments. Testing more combinations between activities required, payment type, and benefit-sharing options could help understanding the variety and complexity of desirable contract preferences. Choice experiments are an option to test some of these trade-offs, but in-depth interviews should be used as a complementary method to explore and understand the interplay between community institutions, PES procedures and individual contract preferences.

5.4 Summary

This chapter has investigated the acceptability of using monetary compensations to restrict the use of forest resources by private landowners through their participation in a Payments for Ecosystem Services (PES) program. Critical issues in PES design involve the targeting of relevant eligibility areas for the provision of ecosystem services; the identification of beneficiaries (e.g. a landowner, a group of landowners, or a broader rural community); the activities beneficiaries need to comply with to receive payments; the compensation amount (i.e. more or less money and/or other type of monetary incentives); the frequency and duration of payments (i.e. more or less years); the way in which such compensation is transferred from payees to beneficiaries (e.g. with a lower or higher

degree of intermediation) and the respect of conditionality through monitoring and sanctioning. While it is impossible to assess individual preferences over all these characteristics, choice experiment methodology allows to unveil some of the trade-offs faced by participants when they decide to join a PES contract.

The present study is based on a choice experiment in an *ejido* where several *ejidatarios* have been receiving payments for biodiversity conservation since 2011. Therefore, the empirical approach is an *ex post* evaluation of preferences based on the elicitation of participants' inclinations regarding the design of a future PES contract. The sample encompasses people who are already familiar with the overall functioning of PES contracts, a condition assumed to reduce the hypothetical bias their answers might have had. While many studies in developing countries are performed with an explorative approach, i.e. the study sample involves people who are not yet receiving any contract, people already involved in a program are also important sources of information for improving policy design. Participant preferences are critical to understand the local functioning as well as the possible consequences of the implementation of conservation policies on natural resource management.

Results have highlighted that in a context of individual ownership of forest parcels, respondents are more likely to accept individual conservation contracts in cash over contracts requiring them to invest part of the compensation received in collective social or productive projects. But because participation is structured around working groups, the role of leaders appears critical in motivating their peers to accept such contract (which complement findings from chapter 6).

The analysis developed here can in turn inform procedural changes aimed at increasing compliance and conditionality, since contractual rules could be better crafted to align with local preferences, payment expectations and development needs. This would make possible to better take into

account contextual aspects, while also reinforcing the cost-effectiveness and participation rate of PES programs. In other words, letting communities adapt PES rules according to their own preferences may not necessarily undermine the cost-effectiveness of the program.

6. PES and collective action in participating communities

This chapter explores how PES contracts have been implemented in an *ejido* characterized by individual possession of forest plots, low level of social capital and limited interest in forest conservation. It specifically addresses the third research question "*How do PES interact with community forest management institutions and influence collective action?".* The chapter contributes to the debate questioning the synergies between contract-based incentives and institutions shaping the collective management of natural resources. The results suggest that PES contracts may introduce new institutions in communities, particulary institutions requiring important level of collective action in domains previously not organized collectively. Therefore, some community leaders must have the agency to articulate PES requirements with the available stocks of social capital in order to enable PES participation and compliance. Nevertheless, PES contracts appear unable to strengthen social capital where the latter is relatively low and therefore PES contracts might be insufficient to encourage the creation and maintenance of institutions promoting forest conservation beyond contract duration.

This chapter uses data collected through a fieldwork research carried out during six consecutive weeks between February and March 2015 in a single *ejido*. Data collection relies on focus groups, semi-structured interviews and participant observation and aims at understanding how PES interacts with local forest management institutions and other community institutions when these programs are implemented in forests collectively owned.

Section 5.1 describes the methodology used to collect data on PES implementation, forest management institutions and collective action among participant and non-participant community members. Section 5.2 descibres how new institutions have been introduced by PES. Section 5.3

illustrates the functioning of these new institutions. Section 5.3 demonstrates that these new institutions might be weak because they contradict other community institutions better accepted by community members. Section 5.4 discusses these results in light of the emerging literature studying the interactiosn between PES contacts and community institutions.

6.1 Data collection and analysis

The *ejido* Flor de Cacao (introduced in section 2.4.2) has the particularity of having been granted two juxtaposed PES contracts running simultaneously. Juxtaposed PES contracts within the same community have happened in several *ejidos* located in the Chiapas REDD+ area, where the government has incentivized the participation of communities with an increase in payments. The existence of these two contracts makes Flor de Cacao (FdC) a suitable community to study its implications in terms of strengthening forest management institutions. I had already been introduced to community members by the forest consultant supervising PES implementation and my presence had been validated by the community assembly and supported by the *comisariado*(Costedoat et al. 2016). I conducted fieldwork research for this article during six consecutive weeks between February and March 2015 and interviewed villagers (*ejidatarios* and non-*ejidatarios*) who were fluent in Spanish. Census data from 2010 indicated that around 75 per cent of villagers understood this language and fluency is traditionally required for any individual involved in collective decision making or transactions with external officials and researchers.

Data collection relied on several methods. First, two focus groups of one hour each, after participants' consent was sought, were used to gather information on historical and socio-political events that had shaped people's life since the *ejido*'s establishment and on the evolution of forest management institutions (Annex 6). The first focus group involved six male *ejidatarios* invited by the president of WG1, while the second involved six women (four female *ejidatarios* and two

spouses of *ejidatarios*) from households participating in WG1 or WG2. The lead author was unable to convince more people to participate.

In addition, semi-structured interviews (Annex 7) were performed with 20 individuals: five *ejidatarios* or spouses of *ejidatarios* involved in WG1, seven *ejidatarios* involved in WG2, six *ejidatarios* not involved in PES contracts and two non-rightholders. The interviews lasted 1h30min on average and covered topics such as their livelihood activities and participation in the *ejido*'s collective decisions and activities, and motivations to join or not the PES program. Interviews were recorded, with consent, and notes were taken during conversations. If it was noticed that recording and note-taking created suspicion among participants, notes were taken only at the end of the conversation. I also spent time observing people's daily life and their participation in resource management activities so to engage into informal discussions. I was invited to attend one session of the *ejido* assembly and a meeting between the two WGs and their forestry consultant, as well as to various other social events. I also joined WG1 members when they performed scheduled collective conservation activities.

Statements regarding forest management institutions program participation and collective action were extracted and translated from focus groups, interview transcriptions and field notes.

6.2 PES working groups as new forest management institutions

When the PES program was introduced in FdC in 2011, its rationale was quite unclear to most *ejidatarios,* with numerous doubts expressed about where payments came from, as well as the purpose of what would be the required activities. PES contracts have been characterized by villagers as "*cobra mono*" (which could be translated as "getting paid for taking care of monkeys"), implying that forest conservation is perceived as a bizarre activity very remotely connected with

the preoccupations of rural forest-owners. Many *ejidatarios* did not believe that the program was targeting conservation and thought that either the government or foreign businesses were trying to dispossess them from their lands, an idea spread by rural organizations in the region. This lack of trust contributed to the early reticence of *ejidatarios* to join the program, alike other parts of the country where trust between community members and government agencies had also been historically weak (Kosoy, Corbera, and Brown 2008). Furthermore, many forest-owning *ejidatarios* in FdC argued that the payment amount per hectare was low compared to the potential economic benefits of alternative land uses, such as pasture for livestock or oil palm and rubber plantations. This context of suspicion initially led the assembly to refuse to participate collectively to PES, as a majority of rightholders voted against such initiative.

Nevertheless, and as noted earlier, dozens of *"risk-takers"* were interested in the program. As the standing forests in FdC are considered by state institutions as commons from a juridical point of view, participation is not possible on *de facto* individual plots. Some community members argued that if the inclusion of forests that are legally owned by an *ejido* under the PES program needs to be approved by the *ejido* assembly, not all forests or *ejidatarios* need to be part of the correspondent contract. They therefore obtained the authorization of the *comisariado* at that time to set up the establishment of WG1 and manage the PES contract autonomously. When *ejidatarios* not involved in WG1 realized that the PES program was indeed delivering economic benefits to WG1 peers, particularly after the payment increased to fit REDD+ program rules, their reluctance to join the program diminished, and a second working group has been established (see below a more detailed description about the emergence of the two working groups).

Around 25 *ejidatarios* not yet involved in either of the two PES working groups recently expressed their interest to create their own third working group. These *ejidatarios* have not joined any of the

two previous groups because they were reluctant to collaborate with any of their respective leaders, or were simply not able to register on time in the list of interested participants for WG2. However, the establishment of a third group has been refused by the *comisariado* (which is also the WG2 leader), arguing that the only way to participate is to join either WG1 or WG2 when they renew or extend their contracts. Several *ejidatarios* considered that the *comisariado* has not the authority to prevent the self-organization of a third working group functioning on similar principles than the two already existing. While the third working group could be legally constituted despite the objection of the *comisariado*, the concrete obstacle appears to be the lack of capacities among other *ejido* members to establish contacts with CONAFOR officials and forest consultants. Finally, few forest-owning *ejidatarios* not interested to participate in PES remain. This is because they are opposed to the principles of PES for ideological reasons or because they consider asking for a logging permit in the near future.

Overall, existing PES working groups can operate as forest management institutions enjoying a relative degree of autonomy from the assembly but having the responsibility to fulfill all contractual obligations contained in the forest management and conservation plan. Both groups are represented by an elected leader, leaders being respectively those individuals who have taken the initiative to set up the groups. In each group, leaders are the interlocutors between group members and the forest consultant supervising the two PES contracts in FdC.

In accordance with CONAFOR guidelines, technical assistance has comprised annual training sessions where all group participants are informed about their obligations and receive general information about forest management and conservation. Many interviewees confessed that they did not entirely understand the content of the training sessions. Although the PES program suggests that the design of the conservation plans should be participatory and involve all participants, both

plans were designed by the respective WG leaders and the forest consultant with little participation from their respective peers.

WG1 is managed by a principal leader and seven other *ejidatarios*, who jointly pursued the creation of the group. All of these community members had previously exercised political, administrative or business responsibilities inside and outside the community, which made them more comfortable with government programs and less distrustful about the purposes of the PES program. WG1 members include mostly *ejidatarios* with valuable assets and diversified sources of income, who generally own larger plots of agricultural and forest lands than the community average (Costedoat et al. 2016). WG1 members have brought between 20 and 40 ha of their de facto owned forests into the program (representing approximately between 1'500 and 3'000 US$ per year for each group members) and payments are distributed proportionally to each member's contribution in hectares.

When non-participant *ejidatarios* expressed their interest to finally joined PES, WG1 members refused to share their benefits with new members through an extension of PES area or to dismantle the group to let the assembly manage the contract. As a WG1 member argued:

"*What did [they] want? That we share our money with people who refused the program at the beginning? It cannot happen, we have a contract [with CONAFOR] and we have complied with the rules so far*" (*Ejidatario* 1, member of WG1, square brackets added)

The emergence of WG2 is a response to such refusal. A non-WG1 *ejidatario* personally discussed the possibility to obtain a new PES contract after gathering information from the forest consultant supervising WG1, as well as from CONAFOR officials. This *ejidatario* demonstrated strong entrepreneurial skills: he is notably the only one in the *ejido* who owns a tractor and he has been a

pioneer in the introduction of rubber trees in the community. He convinced other *ejidatarios* that since all *ejido* parcels are *de jure* commonly owned, a new PES group could be constituted as soon as *ejidatarios* owning forest areas, and not yet receiving benefits from WG1, were included in it. WG2 application was accepted by CONAFOR in 2013.

WG2 mostly encompasses *ejidatarios* with smaller agricultural and forest parcels than WG1 members. WG2 *ejidatarios* have generally brought between 5 and 25 ha of forests into the program with a minority of WG2 members (including the group's leader) not owning any parcel of forest. The WG2 leader decided to distribute more money to small forest owners (comprising *ejidatarios* who do not own forests) to ensure that every participant receives a sufficiently attractive payment amount. Interviewees do not seem to know on which basis the distribution occurs but, for the first annual payment in 2013, the WG2 members interviewed generally said they received a total of 2000 MXN per year (around 153 USD) while larger landowners received the equivalent of 800 MXN/ha/year (61 USD), usually representing between 8000 and 20000 MXN (610 to 1'500 USD) per year.

WG2 does not only differ from WG1 because of the social composition of the group but also because of changes in PES guidelines between 2011 and 2013. WG2 members notably have the obligation to invest 40 per cent of PES payments in the collective building of a fire control tower in the 2nd year. Many WG2 members felt disappointed because they expected to receive the same monetary sum than WG1 members and they did not understand why CONAFOR now obliged them to dedicate funds to a project poorly related to their livelihoods.

Although most *ejidatarios* in both groups would prefer higher payments, many participants recognize that the program has significantly improved their income and are therefore quite satisfied about the program benefits(Costedoat et al. 2016). When fieldwork concluded, WG1 members had

started to discuss (internally and with the forest consultant) the possibility to renew their contract. According to the consultant, the chance to be renewed is high as forests in FdC have many of the characteristics targeted by PES program rules. Interviewed group members unanimously endorsed the renewal but they were not aware that they would then be required to spend 40 per cent of their PES revenues in collective conservation activities.

6.3 The functioning of respective Working Groups

The functioning of both groups is very similar and mostly consist in performing the activities scheduled in the forest management and conservation plan. At the beginning of each contract, signs explaining about the existence of the PES program were placed near the forests included in the PES contracts. Twice a year, both groups are expected (i) to collect waste along the road (in order to avoid the risk of forest fires), (ii) to establish and maintain firebreak fences along the borders with the neighbouring *ejido* and, (iii) to set a forest monitoring brigade in charge of patrolling the PES forests periodically. Each brigade is composed of group volunteers who have registered their name at the start of the contracts, but in practice the brigade is only used to assist group leaders in overseeing collective conservation activities when undertaken.

Both WGs often schedule such activities during the same week, and the participants have to contribute to daily expenses, such as food or gasoline. Days of work are not paid but are mandatory to receive annual payments, and a presence list is used to control for any missing participant. Brigade volunteers take pictures of the group activities, and such pictures are then sent to the forest consultant who incorporates them as a proof of compliance in the monitoring report delivered to CONAFOR. Female members from both WGs are never present as a community norm prevents them from participating in outdoor collective activities. However, female WG members send a male relative to contribute to collective activities in order to remain eligible for future payments.

Group leaders do not directly monitor deforestation restrictions on targeted PES land plots, but they remind WG participants of their contractual obligations in every meeting. CONAFOR officials have occasionally monitored forest parcels on a random basis. Some group members responsible of minor contract violations have been warned by CONAFOR officials and told that they might not be entitled for future payments if their forests continue degrading. Sanctions have not been applied as no repeated offend has been reported. WG leaders need to motivate and persuade their peers before realizing each group activity. They do so arguing that the effort required is quite minimal (few days per year) while the annual payment received is significant in comparison to the cost of performing such activities. During WG1 activities, several participants openly expressed their lack of enthusiasm but still cooperated, as returning to the village is only possible when planned activities are completed.

In summary, respective groups must comply with broadly the same obligations contained in the forest management and conservation plan, with the notable exception that the second group has stricter requirements on the use of PES funds. PES have therefore enabled the performance of collective forest conservation activities and incentivised the compliance strict forest conservation rules, albeit limited only to WG participants and probably only during contract duration.

6.4 Articulating FMI with other community institutions

The functioning of PES working groups as autonomous FMI has been associated with the development of new collective activities related with forest conservation, where collective action in forest management never existed prior to PES implementation. After the introduction of PES, fuel wood extraction and hunting of small animals in the targeted forests are still widespread while land-use change remains limited but still happens. Even before the introduction of PES, most *ejidatarios* preferred to let forest plots intact because they are far away from the village center.

Subsistence agriculture (beans, corn and chile) are perceived as easier in the riversides close to the village. Several PES participants have also been able to use PES monetary benefits to rent arable land in this area. However, a number of families have still considered turning some of their owned forests into new productive activities such as cattle farming, oil palm or rubber trees. Seemingly, other families, who think that available arable plots seemed increasingly prone to pests and have insufficient yield to nourish their families, are tempted to turn forests into new agricultural parcels for their adult children, even if these parcels would be at a considerable walking distance from the village centre. A female *ejidatario* argued:

"*If we were living in the middle of the ejido [i.e. along the highway], we could benefit much more from our land. […] Step by step, people will move [close to the forested parcels], there is not enough fertile land for everybody [near the village]. We have so many kids, where will they find parcels to work?*" (*Ejidatario* 3, member of WG2, square brackets added)

Nevertheless, during fieldwork, more open conflicts took place following the when the comisariado refuses to deliver authorization to extract trees from parcels, independently of the fact of participating or not in a PES WG:

"*Before, nobody could tell me what to do with my trees, because each of us is the owner of his parcel. But now, with the PES program, it is forbidden to cut trees. [The consultant] said it only concerns members of PES working groups but the comisariado says everyone is affected*" (*Ejidatario* 4, not involved in any PES working group, square brackets added).

This new rules is a consequence, as mentioned in previous sections, of the obligation of communities involved in PES contracts targeting REDD+ early action areas to carry out a community land planning exercise. Since all forest are collectively de jure owned by the assembly,

REDD+ procedural rules state that land-use rules should also affect forest not included in PES contracts, independently of the fact that PES are managed by the community assembly or by decentralized working groups. In principle, this land-use planning exercise had to be developed anticipatively under the supervision of the forest consultant, based on inputs from existing PES forest management and conservation plans, but in practice it was conducted between the consultant and the community *comisariado* acting as community representative. Subsequently, during a community assembly held at the end of 2013, the *comisariado* declared that he has the legal obligations to stop delivering logging permits, in accordance with the recommendations of the land-use planning exercise and the correspondent report approved by CONAFOR.

During fieldwork, many *ejidatarios* openly accused the *comisariado* of unilaterally deciding on the land-use planning and the logging permits issue, and of misusing *ejido* funds (this last accusation being recurrent against many *comisariados* but rarely proven by evidence). Few weeks after fieldwork was concluded, a majority of *ejidatarios* forced the *comisariado*'s resignation. Some WG2 members also wanted him to quit from his role as WG2 leader, since he had been receiving payments without owning forests himself and disappointed by the low amount of money they received compared to WG1 members. As of today, however, he continues to lead WG2, partly because nobody else has been willing to replace him. [15]

6.5 Discussion

The findings presented above contribute to the burgeoning literature on the ability of PES to improve the collective management of forests. The results showed that there were already forest

[15] While I have not returned to the village since these changes, I do not know precisely if benefit-sharing rules, forest conservation rules or group decision-making procedures have been later renegotiated. The results are then mostly based on the quotes and observations collected while WG2 leader was still *comisariado*.

management institutions prior to PES implementation but they mostly consisted in a permissive application of governmental legislation. PES implementation contributed to create new FMI at sub-community level, taking the form of autonomous working groups managed by a leader able to motivate group members to perform scheduled collective conservation activities while complying with strict land-use change rules. In a second time, PES fostered the development of a land-use planning exercise at community level, but this exercise has led the community *comisariado* to subsequently increase his power to enforce FMI without consulting the community assembly. Such prerogative has been refused by a majority of community members, who subsequently dismissed him from his position. This conflict might indicate that if PES contract ends, FMI could be restored to the statu quo prior to PES implementation. I discuss these results considering the literature on the importance of social capital in guaranteeing the stability of institutions at community level (Cleaver 2002; Ishihara and Pascual 2009; Klooster 2000).

As the results, have illustrated, PES are not implemented in a vacuum, but generally intend to provide incentives to community members to better comply with governmental forest regulations, and particularly to try to embed forest management institutions promoting conservation into community institutions. Crafting effective institutions requires coordination (between communities and governmental agencies) and cooperation (between community members) (Muradian et al. 2013). Natural resources management scholars recognize that better forest conservation outcomes can be reached at the condition that community institutions enable collective action and motivate pro-nature behaviours but warned that it is very difficult to externally recraft community institutions (Agrawal and Gibson 1999; Muradian et al. 2013; Ostrom 1990). While some evidence suggests that PES interventions, among other incentive mechanisms, can improve social capital , which in turn contribute to better collective action and

the development of stable FMI (Agrawal, Chhatre, and Gerber 2015; Nieratkaa, Bray, and Mozumder 2015; Speelman et al. 2014), in other contexts, PES incentives have not proven able to build enough social capital and (re-) craft stable and legitimate local institutions (Adhikari and Agrawal 2013; Rico García-Amado et al. 2012).

I argue that the way that PES have been implemented in the studied community appears insufficient to achieve coordination and cooperation because the community lacks a sufficient level of social capital enabling collective action (Ishihara and Pascual 2009). I emphasize the discussion on the following limits: i) PES requirements try to impose forms of collective action that did not previously existed in the community, ii) the community does not a have collective decision-making procedures allowing the consensual participation into PES and iii) PES implementation does not rely on a participative process including all forest managers.

Forest management institutions are affected by institutional arrangements at multiple scales (mostly governmental regulations and community rules and norms) (Agrawal and Gibson 1999). Consequently, every community is characterised by specific forest management institutions which might (or might not) be conducive to collective action enabling forest conservation. PES contracts can appear limited in transforming local institutions because they remain top-down approached aiming at reaching short-term results, while grounded social norms or other local institutions may change only slowly (Agrawal and Gibson 1999; Berkes 2004). The case study highlights the influence of property rights over forest management institutions: while governmental regulation, including PES programs considers forest as collectively owned and managed, community members sees their forests as individual plots. In that sense, PES introduce new sets of activities, particularly collective conservation activities that did not exist in the community prior to PES implementation.

Engaging in collective conservation activities requires the mobilization of social capital because it is often necessary to explain how the collective interests of individuals are affected by such activities, but also suppose that some individuals have the power to organize these collective activities (Ishihara and Pascual 2009). When PES do not fit with pre-existing management institutions, they can undermine individual values and social norms shared by community members and eventually lead to environmental degradation in the absence of external incentives (Chervier, Le Velly, and Ezzine-de-Blas 2017; Muradian et al. 2013; Rode, Gómez-Baggethun, and Krause 2015). In FdC, the main motivations underpinning collective conservation activities appears related with external payments, so it is argued that it is unlikely that these activities will be maintained beyond contract duration because these motivations are instrumental (Clements et al. 2010; Rico García-Amado, Ruiz Pérez, and Barrasa García 2013). As argued by Hayes et al. (2015), rule maintenance is more likely if some forest management rules already existed prior PES implementation. In other words, if a community already had a collective agreement regarding FMI, PES can in principle more easily strengthen these institutions, as compared with the case of communities with weak FMI. In communities where PES rules contrast sharply with pre-existing forest management rules, PES might only delay deforestation because FMI structured around working groups appears to constitute only weak institutions needing considerable external incentives and sanctions to be maintained. Weak decision-making procedures prevent the collective negotiation about the scope and means of FMI and therefore reinforce the perception that some rules are imposed by external actors and do not correspond to the collective interests of community members.

Another indication that community members in FdC have an insufficient level of social capital is related to their collective decision-making procedures. While in principle the community assembly

is the supreme decision-making institutions, it is often difficult to find a consensual agreement between more than 300 rightholders. So, in practice, most decisions consist in approving (or not) by simple majority the proposals of the *comisariado*. Nevertheless, decision making has been conflictual in the history of the community. On the one hand, the majority can change across time, as seen in the case of decision to participate in PES. Notably, a tacit approval of the *comisariado* decision at one moment can become a firm opposition when several community members are directly affected by this decision. On the other hand, the *comisariado* can occasionally take "off-stage" decisions without explicitly consulting the assembly (Wilshusen 2009). The perception of land-planning exercise as a unilateral decision has notably contributed to undermine the trust in the *commisariado*. Overall, PES implementation in itself considerably rely on few community leaders acting as representatives of all PES participants (Milne and Adams 2012). This phenomenon can be explained by the fact that a majority of community members do not have the skills to manage a working group, notably the ability to negotiate with forest consultant or governmental officials. Nevertheless, it highlights that PES do not always rely on a participative process allowing all actors affected by FMI to express their point of views and contribute to decision making (Lund 2015). If the purpose of PES is to better embed FMI into community institutions, lack of participation can increase the enforcement of rules perceived as coercive, which in turn do not improve the social capital between community members and governmental officials.

Institutions are a way to solve social dilemma because they shape individual behaviours in a way that individual actions do not harm collective interests (Agrawal and Gibson 1999; Ostrom 1990). Crafting FMI is nevertheless a process consisting in negotiating management power and responsibility between actors at different scales, as highlighted by co-management frameworks

(Adger, Brown, and Tompkins 2005; Olsson, Folke, and Berkes 2004). In doing, procedures to resolve, rather than ignore conflicts might improve the trust in institutions and stakeholders and contribute to foster collective action. External actors such as forestry consultant or government officials should therefore have a more fundamental role in catalysing the collective adoption and legitimate enforcement of new forest management rules favourable to social interests. Multi-level cooperation and flexible institutions are needed in order to empower the autonomy of local actors and associate these institutions with social meaning, for example internalised norms of forest conservation (Muradian et al. 2013; Oldekop et al. 2013).

In conclusion, this case study has contributed to the debates about the interaction between incentives, social capital and institutions of collective forest management. Overall, PES are not a one one-size-fits-all environmental policy able to straightforwardly transfer the burden of forest conservation to community members. It appears important to articulate PES with other incentives and policies, in order to create a framework able to solve social dilemma while favouring the empowerment of community members. Institutions are affected by decisions at several scales, so the ability of incentives to define particular scope and means of institutions is far from evident. Incentives can nevertheless strengthen forest management institutions if they rely on participatory processes, if the initial levels of social capital are sufficiently high and with the gap between pre- and post-PES institutions is limited.

6.6 Summary

This chapter has examined the ability of PES contracts to build forest management institutions at community level, a condition expected to foster the permanence of conservation outcomes beyond contract duration. PES implementation outcomes are shaped by community institutions such as tenure rights, collective decision-making processes and rules and norms fostering collective action.

In turn, these institutions affect decisions to participate, motivations to comply and ability to create forest management institutions.

Results have described how PES have been implemented in one community where participants have organized in two autonomous groups with juxtaposed PES contracts. Leaders of both groups, with the help of a hired technical assistant, have been able to motivate group members to collectively perform conservation activities and prevent land-use change. However, such outcomes are unlikely to last beyond contract duration because both payments and the accompanying plan are insufficient to foster long-term forest management and conservation. While local leadership plays a key role in temporarily transforming PES incentives into collective action, PES alone are unable to strengthen social capital where the latter is currently low and to build adequate institutions for long-lasting forest conservation.

The following chapter aims at understanding the preferences of community members over PES contracts' characteristics. In doing so, a choice experiment approach is carried out to test how the type of TSP but also the degree of collective participation, the use of payment benefits and payment levels influence the decision to accept or not a PES contract. In doing so, heterogeneity of preferences is assessed in order to explore how collective decision-making can be explained by differences in access to elected positions within communities.

7. Conclusion

PES have been implemented in various developed and developing countries. These instruments have been presented as incentive-based contractual approaches able to effectively generate better forest conservation outcomes in a cost-effective way. This conceptualization has nevertheless been challenged notably because many PES programs are sponsored by governments and therefore include various side-objectives such as rural development. Furthermore, a significant proportion of PES programs have been implemented among collectively-owned forests, so there is a knowledge gap about the ability of PES incentives to interact with community institutions while improving collective action within communities but also between community members, governmental officials and other stakeholders.

This dissertation has relied on a case study approach to explore how PES can contribute to avoid deforestation in the state of Chiapas, Mexico. The dissertation has specifically investigated the outcomes but also the processes characterizing PES implementation. While the findings clearly indicated that PES can be environmentally effective in forests characterized by important pressures on deforestation, factors such as the volatility of PES procedural rules and funding, the heterogeneous capacities of technical service providers in mainstreaming PES implementation among community institutions and the lack of reliance over participative decision-making processes at community levels might prevent the establishment or the maintenance of forest management institutions able to motivate cross-scale collective action.

The following sections summarize the findings and present the theoretical and methodological contributions of this dissertation, as well as the policy recommendations and the area for future research.

7.1 Summary of findings

This dissertation has relied on various empirical methods in order to better understand the processes and the outcomes of PES implementation. Chapter Three has notably measured PES additionality in a region of Chiapas characterized by important deforestation trends and where numerous PES contracts have been implemented since 2005. Using a counterfactual obtained from covariate matching method and a difference-in-difference estimator, the chapter has demonstrated that PES contracts can generate important additional forest conservation, even if deforestation has still occurred within forests included in PES contracts.

Chapter Four has investigated how technical service are influenced but also influenced PES implementation in the state of Chiapas. Findings revealed that service providers differ considerably in terms of motivations to supervise PES programs, economic dependence to these programs but also in terms of organizational characteristics. These differences are manifested by different strategies to deal with changes in PES procedural rules and funding but also in adapting to complex community contexts. However, the results suggest that service providers able to cover their logistical costs by other sources than PES payments are also the ones more likely to concentrate PES in circumscribed areas, potentially exacerbating territorial inequalities between areas in function of the types of intermediaries supervising PES implementation.

Chapter Five has analyzed the preferences of community members in terms of PES contracts characteristics in one community simultaneously receiving two PES contracts. Results have highlighted that most participants prefer individual contracts entirely in cash to any other contracts based on collective participation or benefit-sharing, including if PES foster investment in collective productive projects. However, analysis of preference heterogeneity has revealed that community leaders state a different pattern of preferences more favorable to collective

participation. Therefore, community leaders are likely to moderate individual preferences and foster the collective participation to PES.

Finally, chapter Six describes how community members have tried to adapt PES to their community institutions. As PES require collective action in domains previously managed individually, some community members have to mobilize social capital to enable participation and compliance of PES contracts. However, the data also suggest that PES do not allow to mobilize enough social capital to enable the durable establishment of forest management institutions in the community, mostly because PES have encouraged community authorities to unilaterally increase their prerogatives without consulting all affected community members.

7.2 Theoretical contributions

This dissertation has proposed a theoretical framework linking processes derived from PES implementation to the generation of conservation outcomes and impacts. In doing so, the dissertation assumes that PES can be effective at short-term, i.e. during contract duration, but that many uncertainties remain in the ability of PES to generate long-term conservation impacts (see Chapter Three). However, the case study has not allowed to consistently address the research objectives. Indeed, on the one hand, the findings do not allow to assess the degree to which PES have generated impacts beyond contract duration. This is mostly due to the difficulty to obtain all the data allowing to measure forest conservation outcomes beyond PES contract and performing an evaluation at a scale large enough to integrate all the factors identified throughout this dissertation. On the other hand, the links between processes and outcomes have not been explicitly evaluated, in the sense that they have not been integrated in a single evaluation framework able to measure the respective influence of technical services providers and forest management institutions on environmental effectiveness.

This dissertation has shown the diversity of motivations and profiles of organizations involved in PES implementation (Chapter Four). It further demonstrates that technical intermediation is not neutral and could even amplify the territorial inequalities by favoring the access to some communities to PES over other communities, eventually already marginalized. While PES programs rely on a budget insufficient to cover all eligible and interested applicants, the effective implementation of PES might follow spatial patterns that do not necessarily correspond to better securing the provision of environmental services.

The dissertation has also advanced the knowledge on the complexity of mobilizing social capital among community members. While several studies have shown how PES can be associated with increased levels of collective action, Chapters Five and Six have highlighted the fact that if initial levels of social capitals are too low, PES can have a detrimental impact on local collective action. While PES can incentivize people to act collectively while they receive payments, payments cannot always generate motivations to act collectively, notably if the purpose of conservation is not well understood or if new forest management institutions have not been negotiated collectively. Therefore, PES in itself do not appear to overcome the barriers to sustainable collective management identified in the literature on common property institutions.

7.3 Methodological contributions

This dissertation has tried to better understand processes of land-use change and decision-making at sub-community levels. In doing so, it relies on different methods associated with different epistemologies.

Chapter Three has indeed tried to identify comparable land-use units in order to measure PES effectiveness through a quasi-experimental framework. In doing so, data from various sources are

aggregated in a single unit, which allows to reduce a selection bias characterizing PES implementation. This analysis is then based on very strong assumption regarding the definition of observable variables used as proxies to take into account complex factors. The other chapters are indeed more able to explore the complexity of collective decision-making and the inequalities shaping such processes, and so far it has not been possible to articulate data from the several chapters into a single evaluation.

Chapter Five has also proposed a methodological innovation consisting in applying Choice Experiment to measure the Willingness to Accept PES contracts among several individuals of the same community. In doing so, it allows to better understanding retrospectively collective decisions and notably the heterogeneous preferences of community members. These tools can therefore help to better tailor PES contracts to the contexts where they are implemented.

At another level, the sampling technique used in Chapter Four has consisted in trying to interview most of the technical service providers involved in supervising PES contracts in the state of Chiapas. In doing so, this dissertation proposes, to my knowledge, the first exploration of the various profiles involved in PES in Mexico. Similarly, the choice of a community receiving simultaneously two PES contracts while being supervised by an independent technical service provider also allows to explore how PES are implemented in communities characterized by low social capital.

7.4 Policy implications and further research

This research makes an explicit distinction between the forest conservation outcomes generated during PES implementation from the impacts in terms of avoided deforestation. In doing so, the findings have highlighted that PES can generate considerable additionality in areas facing

important deforestation trends. Nevertheless, this dissertation has also emphasized that deforestation is not straightforwardly avoided by PES programs, so there is a need for more continuity in PES strategy and policy cycle. This thesis argues that PES can be an effective instrument but that it is important to promote policy-mixes able to articulate processes of institutional recraft promoting collective action both at community levels but also at supra-community levels. Therefore, PES do not constitute in itself a "win-win" solution but should rather be seen as one among other incentives to better align the behaviors of rural community forest managers with the social interests of other social actors.

The debates over PES effectiveness could integrate the perspectives of socio-ecological systems and of the literature on the institutions promoting collective management in order to understand how PES can help to resolve social dilemma. As social dilemma can occur considering at least two dimensions (intra-community and between communities and governmental agencies), further research is needed to better understand the conditions upon which PES are able to strengthen forest management institutions, and through which causal channels these institutions are contributing to avoid deforestation while increasing cross-scale collective action.

The theoretical framework developed in this dissertation could be improved to enable an assessment of PES effectiveness considering a single scale, e.g. at state or national level. Such analysis would require not only considerable amount of data but also an explicit coding of variables able to characterize the diverse institutional and environmental characteristics of participant communities. Such framework would further also help policy makers to improve the theory of change used to design conservation policies, and enable the development of longer policy cycle favoring adaptive management while taking into account the heterogeneity of contextual characteristics affecting the performances of these policies.

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Annexes

Annex 1. Sources of data used in Chapter 3

Database available online:

Census data at village level are available in the website of the Mexican National Institute of Statistics and Geography (INEGI): http://www.inegi.org.mx/

Administrative data for *ejidos* and communities are published in the online database of the Mexican National Agricultural Registry (RAN): http://phina.ran.gob.mx/

List of the forest owners participating to PES programs are published each year by the Mexican National Commission of Forests (CONAFOR): http://www.conafor.gob.mx/

Geo-referenced information available online:

Digital elevation model (DEM), municipal and state boundaries as well as localities position are available in the website of the Mexican National Institute of Statistics and Geography (INEGI): http://www.inegi.org.mx/

PES program and Special program for Lacandon rainforest eligibility areas are published each year by the Mexican National Commission of Forests (CONAFOR): http://www.conafor.gob.mx/

Protected areas are available in the online database of the Mexican National Commission for Knowledge and Use of Biodiversity (CONABIO): http://www.conabio.gob.mx/informacion/gis/

Deforestation risk index is published by National Institute of Ecology and Climate Change (INECC) and is available at: http://www.inecc.gob.mx/irdef-eng

International boundaries are published by the website Global Administrative Areas (GADM): http://www.gadm.org/

Geo-referenced information available with restriction:

PES polygons can be available upon request with the leader of Forest Environmental Services unit (*Gerencia de servicios ambientales del bosque*) at CONAFOR

Geomorphologic map can be obtained from ECOSUR

Ejido boundaries have not been officially published by an organization, so the map has been elaborated by combining several unpublished sources. Therefore, this map cannot be provided.

Land use and land use change maps have been generated from Spot 5 satellite images bought from the French National Centre for Space Studies (CNES) through the Incentive for the Scientific use of Images from the Spot system program and through the ERMEX project, and therefore cannot be shared.

Annex 2. Questionnaire used to collect data for chapter 4 (in Spanish)

A) Datos generales

Nombre del entrevistado

Nombre y descripción de la organización (año de fundación, objetivos, tipo de expertos, sponsors,…)

Si tiene una oficina, dónde se ubica?

Nivel de estudios del entrevistado

Capacitaciones recibidas

Experiencia profesional antes de ser acreditado por la CONAFOR (en particular en colaboración con organismos públicos, y razones de cambio de profesión)

Su posición actual le parece más favorable qué posiciones pasadas? Porqué?

Usted ha trabajado con otros programas de política pública además del PSA? Cuáles son las mayores diferencias entre el PSA y esos otros programas?

Es difícil de conseguir la certificación para ser prestador de servicios técnicos en servicios ambientales? Por qué si o por qué no?

Está preparando o ha preparado otra certificación de la CONAFOR? En caso afirmativo, cuál/es?

Si es prestador independiente, qué parte de su ingreso representan los PSA (alto: mi nivel de vida depende del ingreso qué viene del PSA, medio: tengo otras actividades profesionales qué eventualmente me permitiría de seguir con el mismo nivel de vida, bajo: el PSA representa una

fracción menor de mis ingresos)? Si el programa desaparece, como seria impactado su nivel de ingresos?

Si es parte de una ONG, que parte del presupuesto de la organización y de su tiempo de trabajo representa el PSA (alto: especializada en PSA, medio: el PSA representa un programa importante dentro de las actividades manejadas, bajo: el PSA no está su actividad principal)?

A su parecer, la remuneración de la asistencia técnica esta adecuada con el costo del trabajo requerido? Algunos proyectos no han sido rentables para usted?

Qué conocimientos técnicos juzga usted qué son necesarios? Sugerencias: usar GPS, conocimientos en agroforesteria o biología,..

B) Generalidades sobre el PSA

En qué municipios trabaja usted en el marco de los PSA?

Cómo se ha elegido esa zona para sus actividades de prestador de servicios de PSA?

Cuantos proyectos de PSA está manejando en la actualidad o ha manejado? Todas las comunidades con quien ha trabajado son comunidades cuyo usted ha realizado propuesta? Los proyectos qué ha manejado se han manejado desde el inicio hasta la fin por usted? Alguna comunidad han cambiado de prestador por usted durante su contrato de PSA? Cuantas comunidades han trabajado con usted con más de uno contrato de PSA?

Nombre ejido Y Municipio	Ano	Modalidad	Hectáreas del PSA	Número de participantes

Según usted el PSA es un mecanismo exitoso? Porqué? Qué falta para ser exitoso?

Según usted, el mecanismo de PSA está en conflicto con otros mecanismos qué usted maneja? Cuáles son las diferencias mayores entre todos los proyectos qué ha manejado?

Cómo se ha enterado de la evolución de los criterios de elegibilidad y de prelación? Qué consecuencias han tenido sobre su trabajo?

Desde qué usted empecé a ser prestador de servicios, cual han sido las otras evoluciones mayores de los PSA?

Según usted que explica esas evoluciones? En particular, quien/que organización ha tenido un papel clave?

Según usted, el formulario de participación y los requisitos para entrar al PSA están claros? La claridad por parte de CONAFOR ha aumentada esos últimos años*? (O es qué su experiencia ha aumentado?) Puede dar ejemplos?*

Cuáles son las personas o organizaciones que le ha ayudado a arreglar problemas eventuales?

Según usted, que parte de su trabajo la CONAFOR no tendría la capacidad de hacer sin la presencia de los prestadores de servicios?

C) El proceso de selección de los participantes

Cómo se ha puesto en contactos con esas comunidades? Por qué razón se eligió esas comunidades

Sugerencias: superficie de bosque, nivel de organización, facilidad de aceso,…

Pagan las comunidades por la formulación de la propuesta? En caso afirmativo, cuánto? Y como se determina la cantidad de pago? Se propone el mismo tarifa a cada comunidad?

En caso negativo, cuáles son vuestros criterios?

Desde que ha empezado a trabajar como prestador de servicio, el pago que pide ha sido lo mismo?

Quién es la persona de la comunidad con quién se ha puesto en contacto?

-Si ya se trabajaba con todas/algunas de las comunidades de PSA antes, qué tipo de proyectos se desarrollaban?

Quién propuso la participación en el PSA? Se han propuesto a todas las comunidades con quien tenía otros proyectos?

-Si es la comunidad o las comunidades las qué se pusieron en contacto con usted, como cree que la conocieron? Puede desarrollar algunos ejemplos?

-Si se hace visitas de identificación de beneficiarios potenciales, con qué criterios las planea

Usted ya ha rechazado de asesorar una comunidad? Por qué motivos?

Cuántos proyectos de los que usted ha diseñado han sido rechazados por CONAFOR?

Por qué motivos? (Por CONAFOR Chiapas o CONAFOR federal?)

Según su opinión, era justificado el rechazo? Esta comunidad ha intentado otro contrato PSA u otro mecanismo?

El rechazo ha cambiado su manera de trabajar? De qué manera?

Cuál ha sido la reacción de la comunidad cuando ha conocido el rechazo? Qué ha sucedido con el dinero si le habían avanzado algún tipo de pago por adelantado?

Sabe si las comunidades qué fueron rechazadas intentaron aplicar de nuevo al programa con otro prestador?

D) Las actividades de prestador de servicios técnicos

Como hace para explicar la meta y los requisitos del programa a las comunidades? *(con detalles)*

A cuantos personas se han dado capacitación? Que tan complicado es?

Como se diseña el PMPM? Qué tipo de actividades son necesarias antes de finalizar el documento?

Usted tenía experiencia en la aplicación de esas actividades antes de ser prestador de servicios técnico en el PSA? Cuáles? Cuáles no?

Cuáles son las actividades obligatorias mas complicadas desarrollar en las comunidades? Porqué? Las mas fáciles? Porqué?

Cuáles son las actividades obligatorias qué no le parecen justificada para el PSA?

Qué tipo de actividades complementarias se implementa en las comunidades?

A su parecer, los participantes al programa siguen la planificación del PMPM de manera autónoma?

Es necesario modificar las actividades planeadas en el PMPM inicial? Porqué?

Qué tipo de verificaciones CONAFOR hace sobre el plan y la aplicación del plan y con qué frecuencia?

E) Las relaciones con otros prestadores de servicios

Hay otros prestadores de servicios técnicos en su zona de trabajo? Quienes?

En qué ocasiones se han encontrado con otros prestadores de servicios?

Cómo calificaría su relación con ellos? Hay una repartición de las comunidades entre usted y sus competidores? Cómo se ha definido esta repartición?

Diría que algunos prestadores de servicio hacen competencia desleal? En caso afirmativo, por qué?

Según usted, cuáles son las características que hace de usted un prestador de servicios?

Si yo fuera el principal representante de una comunidad, qué argumentos pondría sobre la mesa para convencerme de trabajar con usted?

Qué amenazas/oportunidades existen en relación con su trabajo de prestador de servicios? Como se imagina su evolución profesional en los siguientes años?

Que recomendaría a la CONAFOR para mejorar la asistencia técnica que reciben las comunidades?

Qué tipo de capacitación/regulación debería proponer la CONAFOR para mejorar sus condiciones de trabajo?

Annex 3. Choice cards used in chapter 5

Code	0	1	2
Decision	Individual decision	Community decision	Entire forest
Intermediary	External service	Community technician	CONAFOR
Use of payment	100% cash	50% productive	50% social

		Choice option 1				Choice option 2				Choice option 3
Survey version	Choice card	Forest	Intermediary	Payment	Use	Forest	Intermediary	Payment	Use	
1	1	2	0	500	0	0	1	250	1	No contract
1	2	2	1	1000	2	0	0	500	1	No contract
1	3	0	2	500	0	1	0	1000	1	No contract
1	4	0	2	1000	2	2	0	2000	0	No contract
1	5	2	1	2000	2	0	2	500	1	No contract
1	6	0	0	2000	1	2	2	1000	0	No contract
2	1	1	0	250	0	2	2	1000	1	No contract
2	2	1	2	250	1	0	1	1000	2	No contract
2	3	2	1	500	1	1	2	2000	2	No contract
2	4	1	2	250	2	2	1	250	1	No contract
2	5	1	0	250	0	2	2	500	2	No contract
2	6	0	1	1000	0	1	0	250	2	No contract
3	1	2	0	250	2	1	1	250	0	No contract
3	2	1	1	2000	1	2	0	250	0	No contract
3	3	0	0	500	2	1	2	2000	0	No contract
3	4	1	1	500	1	0	0	2000	2	No contract
3	5	0	2	1000	0	1	1	500	2	No contract
3	6	2	2	2000	1	0	1	500	0	No contract

Note. Based on the expected ranking of preferences, an efficient design consisting of 3 survey versions of 6 choice cards each has been generated.

Annex 4. Robustness test regarding class probability function

Class probability function	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Constant	1.24 (0 .33)***		1.14 (0 .37)***		1.44 (0.63)**		1.30 (0.61)**		0.80 (0.33)**		0.35 (1.15)	
Has been elected to a management position in the community (D)	**-1.35 (0.66)****		**-1.43 (0.67)****		**-1.36 (0.67)****							
Group B (D)			.34 (0.65)		0.49 (0 .69)		0.29 (0.64)		0.03 (0.59)			
Number of cows							0.00 (0 .02)					
Plot Size (ha)					-0.01 (0.02)		-0.02 (0.02)					
Male (D)											-0.49 (0 .94)	
Age											0.02 (0.02)	
Class probability in % (segment 1/ segment 2)	70.5	29.5	70.4	29.6	70.4	29.6	69.1	30.9	69.2	30.8	68.7	31.3

Note. Each model corresponds to different combination of variables used to explain the segments in the Latent Class estimation. D=dummy variable. Robust clustered standard errors between parentheses. ***, **, * = statistical significance at 1%, 5% and 10%, respectively.

Annex 5. Simulated probabilities to accept specific contracts

MNL			X3: PAYM				
X1: DECI	X2: TESP	X4: USEP	0	500	1000	1500	2000
Individual	External	100% cash	64,2%	75,8%	**84,5%**	90,49%	94,32%
			[45,82 79,21]	*[58,40 87,46]*	***[69,59 92,87]***	*[78,61 96,10]*	*[85,38 97,92]*
		50% cash, 50% social	47,4%	61,1%	73,2%	82,7%	89,3%
			[27,87 67,68]	[39,19 79,24]	[51,39 87,62]	[63,08 93,01]	[73,20 96,20]
		50% cash, 50% productive	44,3%	58,1%	70,8%	80,8%	88,0%
			[27,41 62,67]	[38,52 75,47]	[50,51 85,17]	[62,10 91,58]	[72,23 95,42]
Individual	Community	100% cash	63,1%	74,9%	83,9%	90,07%	94,05%
			[43,26 79,33]	*[55,50 87,71]*	*[67,20 92,96]*	*[77,16 96,06]*	*[84,82 97,82]*
		50% cash, 50% social	46,2%	59,9%	72,3%	82,0%	88,8%
			[27,76 65,66]	[38,59 78,05]	[50,78 86,81]	[62,97 92,39]	[73,77 95,71]
		50% cash, 50% productive	43,1%	57,0%	69,8%	80,1%	87,5%
			[23,26 65,51]	[33,30 77,81]	[45,21 86,58]	[57,75 92,21]	[69,42 95,59]
LC (segment 1)							
Individual	External	100% cash	31,80%	45,04%	**59,0%**	71,69%	81,65%
			[15,06 55,08]	*[22,71 69,56]*	***[32,23 81,36]***	*[43,01 89,47]*	*[54,14 94,37]*
		50% cash, 50% social	25,0%	36,9%	50,7%	64,4%	76,1%
			[9,82 50,44]	[15,39 65,31]	[22,90 78,07]	[32,26 87,28]	[42,94 93,06]
		50% cash, 50% productive	21,9%	33,0%	46,4%	60,3%	72,8%
			[8,71 45,09]	[13,73 60,35]	[20,59 74,27]	[29,31 84,79]	[39,52 91,62]
Individual	Community	100% cash	28,74%	41,48%	55,48%	68,65%	79,38%
			[12,73 52,72]	*[19,51 67,46]*	*[28,25 79,78]*	*[38,54 88,44]*	*[49,60 93,77]*
		50% cash, 50% social	22,4%	33,6%	47,1%	61,0%	73,3%
			[8,27 47,90]	[13,11 62,93]	[19,81 76,21]	[28,43 86,03]	[38,62 92,31]
		50% cash, 50% productive	19,5%	29,9%	42,8%	56,8%	69,8%
			[7,31 42,64]	[11,65 57,89]	[17,72 72,22]	[25,67 83,35]	[35,31 90,73]
LC (segment 2)							
Individual	External	100% cash	95,93%	98,47%	**99,44%**	99,79%	99,92%
			[87,81 98,72]	*[94,89 99,55]*	***[97,96 99,85]***	*[99,20 99,95]*	*[99,69 99,98]*
		50% cash, 50% social	53,7%	76,1%	89,7%	96,0%	98,5%
			[24,58 80,55]	[45,77 92,28]	[68,66 97,18]	[85,06 99,00]	[93,68 99,65]
		50% cash, 50% productive	50,1%	73,3%	88,3%	95,4%	98,3%
			[21,49 78,68]	[41,51 91,41]	[64,83 96,84]	[82,75 98,88]	[92,60 99,61]
Individual	Community	100% cash	97,68%	99,14%	99,68%	99,88%	99,96%
			[91,45 99,40]	*[96,53 99,79]*	*[98,64 99,93]*	*[99,47 99,97]*	*[99,80 99,99]*
		50% cash, 50% social	67,4%	85,0%	93,9%	97,7%	99,1%
			[32,86 89,76]	[56,05 96,18]	[76,90 98,63]	[89,69 99,52]	[95,79 99,83]
		50% cash, 50% productive	64,2%	83,0%	93,1%	97,3%	99,0%
			[29,20 88,61]	[51,82 95,71]	[73,75 98,46]	[88,02 99,46]	[95,06 99,81]

Note: Probabilities are calculated using the formula presented in equation 7. Confidence intervals (95%) are below each probability (square brackets). Following Hosmer and Lemeshow (2000), the confidence interval of such probability is obtained by introducing in equation 7 the lower an upper bounds of the estimated confidence interval of the estimated logit.

Annex 6. Questionnaire used to perform focus groups described in chapter 6 (in spanish)

A) Funcionamiento interno del ejido

¿Con qué frecuencia se reúne la asamblea?

¿Cómo se decide la integración de nuevos ejidatarios?

¿Qué derechos tienen las familias de pobladores o avecindados en el ejido?

¿Desde cuándo las mujeres pueden ser ejidatarias?

¿Qué reglas sobre el comportamiento de las familias, o sobre el manejo de la tierra y los bosques existían en los primeros años del ejido han desaparecido? ¿Por qué motivo?

¿Cómo se aprueban nuevas reglas? ¿Cómo se aplican esas reglas? ¿Ahora, qué comportamientos pueden ser sancionados? ¿Qué forma toma la sanción?

¿Se han escrito las reglas pasadas o las actuales, por ejemplo en algún reglamento o actas que pueda consultar?

Ejercicio: Listar reglas formales e informales qué existen: como aparecieron, a quien están dirigidas, como se aplican,…

¿Cómo se decide la forma de cooperación para los servicios públicos (e.g educación, salud, electricidad,..)?

¿Cómo se aprueba la creación (t/o la desaparición) de nuevos comités?

¿Cómo se aprueba la creación (t/o la desaparición) de nuevos grupos de trabajo?

Ejercicio: pensar el propósito de los diferentes comités y grupos de trabajo y en qué contexto aparecieron y ver cuáles son percibidos como más legítimos y cuales han creado conflictos.

A) Participación en programas del gobierno (o de otra organización).

¿A qué apoyos están participando los miembros del ejido? ¿Qué diferencias mayores se nota entre la manera de funcionar de esos apoyos?

¿Cómo se ponen en contacto con el ejido las organizaciones no gubernamentales o los prestadores de servicios qué han apoyado a la gente del ejido? ¿Quiénes son?

¿Cuáles fueron las etapas para qué los miembros del ejido decidieron participar al programa de PSA?

¿Qué trámites y/o actividades han tenido qué hacer los miembros del ejido para participar?

¿Cómo se ha decidido la repartición de los beneficios del programa? ¿Esta forma es distinta qué otros programas otorgados por el gobierno?

¿Cómo explicar qué se ha conservado la montaña hasta ahora?

Annex 7. Interview guide for semi-structured interviews used for chapter 6 (in Spanish)

A) Tenencia de la tierra y participación en las decisiones del ejido

Si usted es ejidatario,

¿Desde cuánto tiempo usted es ejidatario? ¿Cómo ha adquirido este título? ¿Qué hacía usted antes de ser ejidatario?

¿Ha vendido o comprado tierra desde su primera adquisición de tierra? ¿Por qué motivos? ¿Cuáles son los obstáculos eventuales para esas transacciones?

¿Según usted, qué beneficios da el título de ejidatario?

¿Usted podría ceder su título a algunos miembros de su familia? ¿A otras personas?

¿Qué otros miembros de su familia son ejidatarios? ¿Por qué querían ser (o no ser) ejidatarios? ¿Si tiene hijas/hijos ejidatarias/ejidatarios, siguen ayudar a usted en su parcela?

¿Usted va regularmente a la asamblea? ¿Usted ha tenido un cargo en el ejido? ¿Por qué? ¿Por qué no?

¿Según usted, cuales son los problemas que se discuten actualmente en la asamblea?

¿Hay reglas qué le parece desfavorables en el ejido? ¿Quién decidió estas reglas?

¿Según usted, hay reglas de la comunidad qué se aplican de manera distintas entre ejidatarios y otros miembros del ejido? ¿Cuales? ¿Cómo se justifica esta diferencia eventual?

¿Usted participa en algún grupo de trabajo o comité? ¿Cuál es la justificación del grupo o comité? ¿Cómo surgió?

¿Hay decisiones del grupo o del comité qué crean conflictos con la autoridad o la asamblea? ¿Cuales?

Si usted no es ejidatario,

¿Desde cuánto tiempo usted está en el ejido?

¿Usted tiene acceso a una parcela?

¿A qué condiciones el ejido otorga tierra y el titulo de ejidatario?

¿Alguien en su familia ha sido ejidatario en este ejido?

¿Usted ha podido ir a la asamblea, o ser miembro de un comité o grupo de trabajo?

¿En qué programa del gobierno usted o personas de su hogar han podido participar?

B) Conservación de los bosques

¿Usted tiene parcelas de montaña? ¿Qué especies son? ¿Cuánto tiempo se necesita para llegar?

¿Desde la adquisición de su tierra, usted ha cortado parte de su montaña? ¿Para hacer qué?

¿De qué manera a montaña beneficia a usted? ¿A su comunidad?

Si usted ha participado al programa de conservación de la CONAFOR,

¿Según usted, porqué motivos esta montaña se ha conservado antes de la existencia del programa de conservación?

¿Existían reglas específicas sobre el uso de la montaña antes del programa de conservación? ¿Esas reglas han cambiado con la participación en el programa? ¿De qué manera?

¿Por qué usted ha decidido de participar en este programa?

¿Qué dudas ha tenido sobre el funcionamiento del programa? ¿Qué ha permitido reducir esas dudas?

¿Toda su montana está incluida en el programa? ¿Usted ha podido elegir qué parte de su montana puede entrar dentro del programa?

¿Si usted tiene montaña que no está en el programa, por qué razones? ¿Usted tiene planes para desarrollar esta montaña? ¿Usted está conservando esta montaña qué no está en el programa?

¿El programa ha funcionado de manera correcta en comparación con sus expectativas? ¿Qué puntos no se han cumplidos? ¿Cómo usted se ha adaptado a eventuales cambios de funcionamiento?

¿Qué actividades ha tenido que hacer para cumplir con las reglas del programa?

¿Esas actividades le parecen útiles para usted? ¿Generan gastos? ¿De qué manera?

¿Usted diría qué ha aprendido nuevas técnicas participando en este programa? ¿Cuales?

¿Para usted, este programa ha generado más ganancias qué gastos? ¿Piensa qué hubiera podido ganar más dinero en la ausencia del programa? ¿Cómo?

¿Piensa usted que el programa ha cambiado reglas de funcionamiento del ejido? ¿De qué manera? ¿En particular, como han evolucionado restricciones de acceso a la montaña?

¿Qué actividades de monitoreo interno del programa se han desarrollado en el ejido? ¿El programa ha contribuido a cancelar reglas o actividades qué se hacía antes en el ejido?

¿Cómo los prestadores de servicios o la CONAFOR han hecho verificaciones de su montaña?

Si se puede, usted quería renovar el contrato de PSA? ¿Si hubiera sido posible, usted hubiera entrado en el otro grupo de trabajo de PSA?

¿Si el programa se cancela, qué haría usted de su montaña? ¿A qué condiciones podría seguir conservando?

¿Según usted, a qué condiciones el ejido podría decidir de una regla interna sobre conservación de montaña?

Si usted no participa al programa de conservación,

¿Por qué usted no entró en ningún de los grupos de trabajo de conservación? Si usted quería entrar pero no pudio, tendría preferencias de entrar en un grupo más qué el otro?

¿Qué elementos le parece interesante de este programa? ¿Qué elementos no le conviene?

¿Piensa usted que el programa ha cambiado reglas de funcionamiento del ejido? ¿De qué manera? ¿En particular, como han evolucionado restricciones de acceso a la montaña?

¿Según usted, a qué condiciones el ejido podría decidir de una regla interna sobre conservación de montaña?

¡Gracias por su participación!