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"We are the city lungs": Payments for ecosystem services in the outskirts of Mexico City

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ABSTRACT

Payments for ecosystem services (PES) have emerged as an incentive-based policy instrument to manage and secure the flow of ecosystem services for human wellbeing. PES implementation has been mostly examined in rural areas but very few studies have paid attention to experiences in rural–urban landscapes that provide critical ecosystem services for densely populated areas. Informed by household surveys and focus groups, we analyze the implementation of Mexico's federal program of Payments for Watershed Services (PSAH in Spanish) in two communities located in the rural–urban fringe of Mexico City, paying attention to landowners' dependence on ecosystem services and both perceived benefits and costs of participating in the PSAH program. We demonstrate that landowners are generally aware of the critical services they provide to the city and beyond but there is a skewed level of knowledge regarding the program objectives and an uneven sharing of its benefits. The latter is influenced by collective organization and environmental history, with higher knowledge and more equitable benefit sharing present in the community with a more long-standing commitment to forest conservation. The PSAH incentive contributes to household income but it is clearly insufficient to motivate strong family and collective action towards halting land-use change beyond the PSAH targeted area. We thus argue that conservation policy in urban–rural fringes needs to be accompanied by effective land-use planning at regional level. This should involve multiple stakeholders and the re-conceptualization of Mexico City surrounding agricultural lands and forests as spaces to be governed for the provision of ecosystem services rather than as areas over which the city can expand.

Introduction

Over the last decade, payments for ecosystem or environmental services (PES) have gained momentum in global and national environmental policy as a tool to achieve ecosystems and biodiversity conservation goals and contribute to resource managers' wellbeing. Albeit introduced in the 1970s to gauge public interest in biodiversity conservation (Gómez-Baggethun et al., 2010), the concept of "ecosystem services" has become extremely popular since the late 1990s after the publication of key articles and reports (Costanza et al., 1997; Daily, 1997). Within these, ecosystem services are generally defined as the direct and indirect benefits that humans obtain from nature, including supporting, regulating, provisioning and cultural services (MEA, 2005).

The idea of rewarding resource managers for the provision of non-rival, and non-excludable ecosystem services is grounded on environmental economics, for which there is a need to internalize environmental externalities through the economic valuation of public goods and services (Engel et al., 2008). In theory then, if one were able to establish incentive-based institutions to pay resource managers for the provision of carbon sequestration, watershed regulation, pollination services, landscape conservation or other non-market accounted services, the chances of developing or strengthening existing resource management practices towards a sustained provision of these services would actually increase (Corbera et al., 2009).

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Payments for ecosystem services have been generally conceived as "a voluntary, conditional agreement between at least one 'seller' and one 'buyer' over a well defined environmental service- or a land use presumed to produce that service" (Wunder, 2008). It has been argued that PES differ from markets for ecosystem services in their underlying institutional framework, with the former being characterized by ill-defined services, with governments, public agencies or NGOs playing a key role in mobilizing public resources to compensate ecosystem service providers through direct payments, and the latter involving a well-defined ecosystem service that becomes a tradable commodity exchanged through a pricing mechanism subject to supply and demand (Corbera et al., 2007a).

The implementation of PES has so far shown that a great number of schemes fail to comply with at least one of Wunder's conditions noted above. In developing country contexts, the ecosystem services being paid for are often poorly defined and therefore weakly monitored, whilst conditionality is low (Corbera et al., 2007a; Muradian et al., 2010). Some countries like Ecuador, Costa Rica or Mexico have developed national PES schemes where payments look more like a subsidy than an actual conditional payment (Muñoz-Piña et al., 2008; Wunder, 2008). Furthermore, PES experiences in developing countries have encountered insurmountable governance and institutional design challenges, such as corruption or pressures from lobbying groups that have geared the rules of the PES scheme towards particular interests (McAfee and Shapiro, 2010; Pattayanka et al., 2010).

For some, PES can become a very useful complement to "command-and-control" conservation approaches (Alix-Garcia et al., 2010, 2012) and can contribute to alleviating poverty (Pagiola and Platais, 2002). However, the latter may only be achieved if the real costs of ecosystem service provision are taken into account (Pascual et al., 2010) and if attention is paid to the legitimate participation of all resource managers and the distribution of costs and benefits in the PES scheme (Corbera et al., 2007a; Kosoy and Corbera, 2010). Empirical evidence on these issues is flourishing and increasingly showing a diversity of outcomes depending on contextual and institutional design and implementation issues (Wunder, 2013). Wunder et al. (2008) found that very few programs formally try to estimate additionality *ex ante*, most, if at all, estimate additionality *ex post*. The problem again is related to the difficulty of reliably quantifying services provision and identifying suitable counterfactuals. Seemingly, Alix-Garcia et al. (2010) highlighted that in many communities forest conservation payments may not translate into behavioural change mostly because these communities were already preserving the forest. However, they also pointed out that PES programs contributed to establish new conservation activities and resulted in a measurable increase on the effectiveness of existing ones. In the tropics, there are many emerging PES initiatives, but very few cases in which the payment is directly related to the measurable quantity or quality of ecosystem services (Pagiola et al., 2005).

Debates around PES contribution to poverty alleviation remain unsettled and the evidence is mixed (Engel et al., 2008; Wunder and Albán, 2008; Wunder et al., 2008). Some have emphasized that PES programs can indeed contribute to poverty alleviation both at regional and local scales. Pagiola et al. (2005), for example, suggested that the Costa Rican PES program shows a relatively high spatial correlation between service provision areas and locations of high poverty. Furthermore, it has been argued that non-income benefits related to PES such as improved tenure security and property rights can indirectly benefit the poorest, specifically if elite capture is addressed (Asquith et al., 2008; Engel et al., 2008; Pagiola, 2008; Wunder et al., 2008). Others, in contrast, have demonstrated that PES design and implementation can be biased against poor households without land titles, which in turn can result in a widening wealth and political gap between right-holders and non-right holders (Corbera et al., 2007a; Rico García-Amado et al., 2011; de Koning et al., 2011). It has also been shown that high transaction costs are also likely to be a great obstacle to ensure the participation of poor households in particular settings (Engel et al., 2008; Pagiola, 2008). This could nonetheless be overcome if communal contracts were established and benefits evenly shared (Wunder and Albán, 2008; Pagiola, 2008).

In response to deforestation and forest degradation, as well as to increase water availability in specific river basins, the Mexican government established in 2003 a national program of Payments for Watershed Services (hereafter referred to as PSAH for its Spanish acronym) (Muñoz-Piña et al., 2008). The program aims to strengthen forest conservation and management practices across the country, paying attention to forested areas located in critical watersheds at high risk of deforestation. In this paper, we assess the implementation of PSAH payments by exploring the perceptions of two participating urban–rural communities located in the outskirts of Mexico City. We qualitatively examine the program's effect on participants' livelihoods and the perceived role of the program in improving community organization, as well as in halting urban sprawl and reducing resource degradation. This is important to understand if PES can be a successful conservation tool in contexts of high land opportunity costs and rapid dynamics of social and spatial transformation.

The article is structured in four sections, including this introduction. The following section introduces Mexico's PSAH program, the research methods and the two selected communities. These communities are located in the same hydrological watershed but differ in the institutional and tenure arrangements that govern community life and forest use in PSAH areas. *Results* section presents the results structured around household's characteristics and dependence on ecosystem services; perceived and actual costs and benefits from participating in PSAH; and people's perceptions on local ecosystem services and the program's likely effect on land-use change. Final section discusses and concludes the paper in the light of existing literature.

Case study and methods

Mexico's PSAH program

Mexico's National Forestry Commission (hereafter referred as CONAFOR) manages the PSAH program under an even larger policy program known as *ProÁrbol*, which brings together all government-supported forestry programs (DOF, 2010). Mexico's PSAH is one of the largest PES programs in the world, both in terms of geographical coverage and dedicated funding. It covered 2.27 million ha in 2009 (Alix-Garcia et al., 2010) and continuous effort has been made to improve the allocation of funds through a more focused targeting approach. Since 2011, the operational rules for *Proárbol* explicitly note that payments should not duplicate other support granted by the federal government for the same objective on the same lands and a modified Forest National Information System has been put in place to monitor all *ProÁrbol* programs' performance and to adequately control the allocation of public funds, including PSAH.

ProÁrbol operational rules observe three sets of scoring criteria to filter and prioritize funding applications. The first set involves criteria for all funded programs under *ProÁrbol*; a second set involves criteria that are relevant for forest management programs; and a third set is specific for each program (Neitzel et al., 2014). Specific eligibility criteria for PSAH applicants include, for example: (1) if targeted lands are located in a micro watershed where other ecosystem service "sellers" already benefit from PSA; (2) if such lands are located in high deforestation risk areas, as defined by CONAFOR; and (3) if they are located in areas with high risk of

suffering from natural hazards and extreme climatic events, as defined by the correspondent National Centre for the Prevention of Disaster (CENAPRED) maps. PSAH participants' activities should preferably focus on forest cover conservation aimed at recharging aquifers and halting soil erosion. *ProÁrbol* operational rules select the applications best fitting such purposes by prioritizing lands that fall in officially declared overexploited aquifers, reduced average surface water availability, anthropogenic degradation, strategic reforestation areas, and biomass densities based on data from the Forest and Soil National Inventory (Neitzel et al., 2014).

PSAH applicants can include individual landowners but mostly consist of agrarian communities and *ejidos*. These are common property regimes where a group of families have usufruct rights over farming lands whilst they share access, withdrawal, management, and exclusion rights over grazing and forest areas. Agrarian communities and *ejidos* are governed by an assembly of right holders that meets monthly and rules over the use of the commons, development projects and other community issues (Muñoz-Piña et al., 2008). Three periodically elected individuals, so-called authorities, are in charge of daily community affairs and they manage revenues from policy programs and projects following, in theory at least, the assembly's adopted decisions. Communities and *ejidos* are eligible to incorporate their forest commons into the PSAH program but a group of community/*ejido* members is also allowed to bundle a number of family-owned forest plots, if they put together a minimum area of 20 ha, and apply to the program with prior authorization from the community/*ejido*'s assembly. In this case, the group is responsible for the application process and fulfilment of program requirements.

National PSAH funding comes from an increase in the water tariff for large consumers (i.e., water bottling companies and large industries with high water consumption levels). An amendment in 2003 of the Federal Rights Law (article 223) earmarked a total of MXN $200 million (US$18.2 million) annually for the PSAH program, representing roughly 2.5% of average annual water revenues (Muñoz-Piña et al., 2008). Such funding has translated into annual payments for individual landowners and communities/*ejidos* ranging between MXN $382 (US$29.30) and MXN $1100 (US$84.36) per hectare, depending on the type of targeted PSAH forest and over a renewable period of 5 years (SEMARNAT, 2010). Payment figures have varied over the years, influenced by changes in the average opportunity cost for maize cultivation (Muñoz-Piña et al., 2008).

Mexico's and other national PES programs face the challenge of adjusting payments to land opportunity costs that vary significantly across space and time, as do the processes that enable or undermine the effectiveness of PES activities. In theory, if these programs offered too little to be considered an economic alternative by ecosystem service providers, applicants would not be interested in enrolling, since the economic return of the desired land use together with PES payments would not be attractive enough. However, PSAH uptake levels have been sufficiently high every year in most of the government's targeted watersheds and very high in forested areas of difficult access and reduced local use (Muñoz-Piña et al., 2008). This can also be explained by the fact that Mexico's communities and *ejidos* most often allocated land under the program which is of either negligible productive value or is subject to other resource management restrictions, as it is the case of our two studied villages. These conditions explain also why the government has been unwilling to increase significantly the PSAH incentive level, for example to bring about more environmental benefits in areas of much higher opportunity costs.

A number of studies have analyzed the performance of Mexico's PSAH and other accompanying PES programs under *ProÁrbol*, including those targeted at conserving biodiversity conservation and developing agroforestry systems. As highlighted above, and partly as a result of somewhat low payments and the selection scoring system, participants are often located in forested areas with low deforestation risk (Muñoz-Piña et al., 2008; Wunder et al., 2008; Alix-Garcia et al., 2010; Perevochtchikova and Vázquez Beltrán, 2012). Additionally, in some of the country's regions, payments have been directed towards forests already targeted by "command-and-control" regulatory measures, such as protected areas (Muñoz-Piña et al., 2008), in order to mainstream or reinforce good practices, forest management and prevent forest degradation.

The existence of such policy overlaps reflects the need for additional resources to compensate against weak – but progressively improved – enforcement of conservation regulations in Mexico and explains the attractiveness of PES incentives in protected areas (Figueroa and Sánchez-Cordero, 2008; Cortina-Villar et al., 2012; Navarrete et al., 2011; Vidal et al., 2013). However, such overlaps also complicate any analysis attempting to disentangle the relative contribution of PES to conservation outcomes (Miteva et al., 2012). Seemingly, the overlaps in the spatial targeting of public policy instruments put into question the efficiency of the resulting outcomes; one can wonder if it would have been more cost-effective to simply dedicate more resources to the previously existing command-and-control instrument rather than to add a new PES-like complementary subsidy.

More broadly, these insights demonstrate the 'non-Coasean nature of PES in practice' (Muradian et al., 2010), at least in reference to PES national programs as designed in Mexico. Payments represent more an incentive for collective action or compensation for reduced access to forest resources or to agricultural markets (Muradian, 2013), as well as a subsidy-oriented fiscal policy to modulate collective and individual incentives for land-use practice and conservation (Pirard, 2012) than a contractual-based transaction for the voluntary provision of an ecosystem service or land-use proxy (Wunder, 2005). When PES programs overlap with other land-use and conservation policy instruments and restrict landowners' management rights, such as protected areas, one cannot infer if such provision is then voluntary.

Mexico City's basin and the two studied communities

Mexico's population has quadrupled over the past 50 years and 78% of it now lives in cities (INEGI, 2011). Rural–urban fringes are areas where rural and urban cultural, environmental, social, economic and institutional features co-exist surrounding cities and large metropolis. These fringes often constitute a heterogeneous mosaic of "agro-forest" and "urban" ecosystems, affected by material and energy flows demanded by both urban and rural systems and subject to rapid change (Allen et al., 2006). They are increasingly a source of valuable ecosystem services for urban populations, providing key agricultural and forest goods to city markets, as well as recreation spaces (Bolund and Hunhammar, 1999; Gutman, 2007; Kroll et al., 2012).

The ecosystem services provided by rural–urban fringes have been rarely studied in Mexico and have been often underestimated, resulting in ecologically unsustainable land-use planning and in limited knowledge over the importance of such landscapes among its urban beneficiaries (Gutman, 2007; Niemelä et al., 2010). Ecosystem services from these areas depend heavily on land management, which is in turn influenced by landowners' degree of control over the ecosystems and resources of their land (Racevskis and Lupi, 2006). Urban sprawl explains to a great extent the degradation of ecosystems in rural–urban fringes throughout the developing world (Díaz-Caravantes and Sánchez-Flores, 2011; Haregeweyn et al., 2012; Inostroza et al., 2013). Competition for land in these areas is significant, and land-use change proceeds fast, driven by increased urbanization due to in-migration from rural areas and out-migration from urban ones.

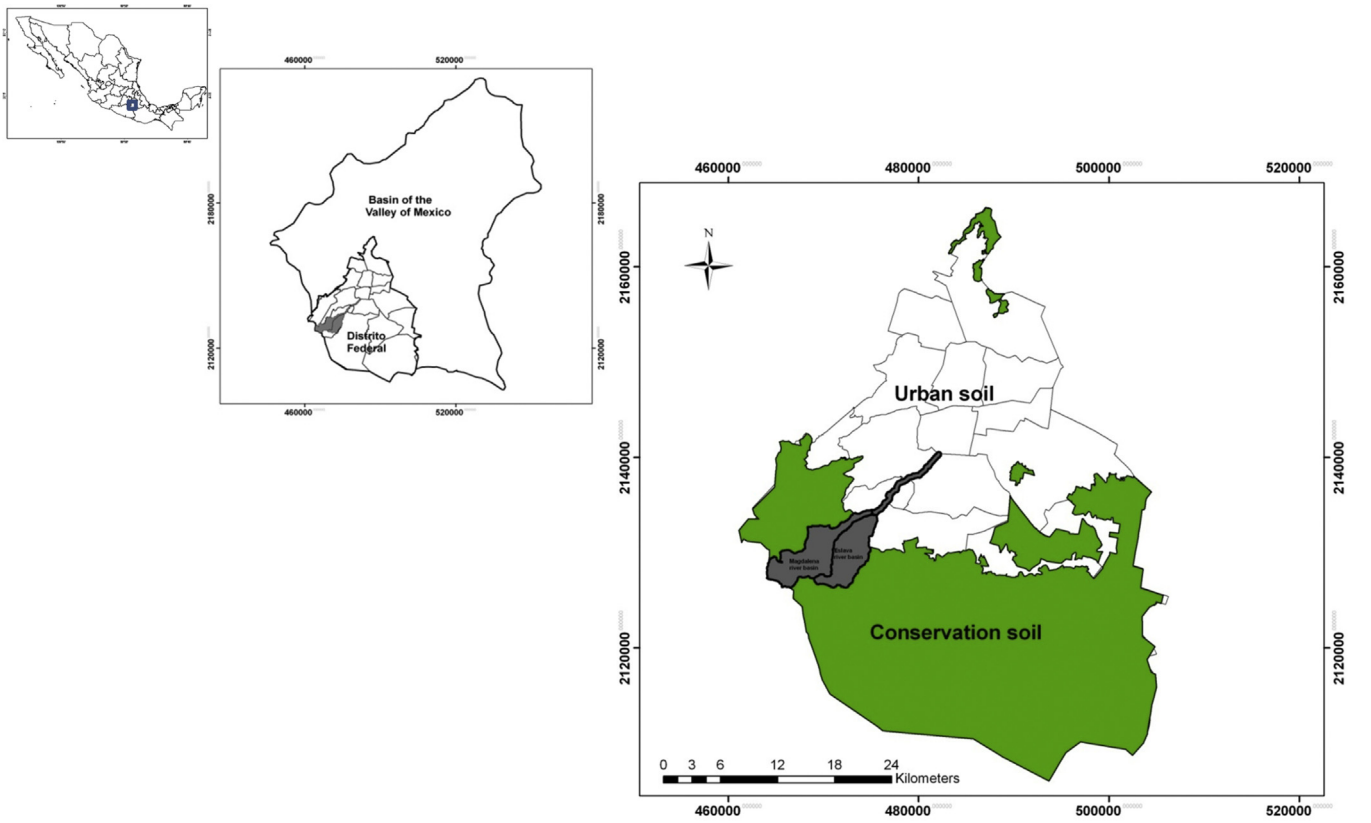

Fig. 1. Location of the Magdalena and Eslava River Watershed (in grey), the Basin of Mexico (in white) and Mexico.

Mexico City and its administrative area (hereafter referred as Mexico DF) spread over an area of 149,342 ha, hosting a population of 20 million people. The city is located at the south west of central Mexico's basin, a closed hydrographical unit that sets at an altitude of 2236 above sea level and covers an area of 9600 km^2. Mexico's City administrative area is divided in (1) soil for urban development, encompassing 59,900 ha (41%), and soil for conservation (SfC), covering 88,442 ha (59%), where agricultural and natural resource conservation are predominantly undertaken (Fig. 1). The SfC is home to 2.2 million inhabitants and 700,000 of them make direct use of natural resources (shaded area in Fig. 1). These people are integrated in 47 urban–rural settlements representing 8% of the population in Mexico DF. The SfC area encompasses 92 agrarian communities and *ejidos* who legally own 55,186 ha, with their land-use activities being constrained since 2000. Timber logging is prohibited except when it is carried out for ecological restoration purposes; land-use change is also forbidden as it is the expansion of urban settlements, and there are pre-defined areas for agricultural and grazing activities (SEDATU, 2012).

Urban sprawl around Mexico DF is the most important driver of forest and agricultural soil loss. Urban expansion can be explained by increasing in-migration to the city from rural areas, which has come accompanied by a lack of urban planning and weak law enforcement, which have favoured real estate developers and have led to high land prices and speculation (Santos and Guarneros, 2006; Aguilar and Lopez-Guerrero, 2013). Illegal squatting in SfC areas has been explained by limited access to housing or real estate property by poor rural in-migrants, rather than by limited urban land (Martínez rivera and Monroy-Ortiz, 2009). At present, more than 15% of the SfC area has been invaded and there is a growing trend towards the occupation of highly productive agricultural land and forests. According to Mexico DF's Natural Resources Management and Administration program, deforested areas comprise 7% of the city's SfC area (SMADF, 2011) and, by 2020, it is expected that illegal occupations will cover around 32% of the SfC area and highly productive farming land is likely to be allocated to fodder production, which has proven to be a more profitable business (Schteingart and Salazar, 2005). These trends are undermining the capacity of the SfC area to provide many critical ecosystem services to a range of beneficiaries in Mexico DF, which include the infiltration of rainwater into the basin aquifers from which the city depends, climate and air quality regulation, habitat provision for biodiversity, environmental education opportunities, research and recreation, and provision of food and raw materials for the city's metabolism (Jujnovsky et al., 2010; Neitzel et al., 2014).

The two communities selected for this study are located in two river watersheds that flow into Mexico DF (highlighted in Fig. 1). The *Magdalena* river watershed (MRW) is a 3000 ha area sitting on the volcanic range of *Las Cruces*, southwest of Mexico City (Jujnovsky et al., 2010). The climate in the watershed is temperate sub-humid and semi-cold, determined by the altitudinal gradient (Dobler, 2010), and the *Magdalena* river is the most important perennial water system in Mexico DF. The watershed forests are relatively well preserved (67% the area is forested) and contain three main plant communities, being the coniferous the most dominant tree species. In 1932, a government decree declared 3100 ha of the MRW a natural protected area and the watershed is also regulated by a 1947 decree that covers a 12 km river stretch (Fernández-Eguiarte et al., 2004).

Most of this land belongs to the *Magdalena* community; property rights covering the area date back to 1535. Requests to be recognized as a community were made to the government in 1945 but they were not granted until 1975. Two thousand three hundred and ninety-three (2393) hectares were

granted to the MRW common shareholders through a Communal Rights Confirmation Presidential Act, which partially overlap with the natural protected area highlighted above. The *Magdalena* community is organized autonomously, and only 250 of the actual 1779 registered shareholders attend regularly the community assembly. The vast majority of residents work in the city and agricultural activities within the watershed have been progressively abandoned (Jujnovsky et al., 2010).

The Eslava River Watershed (ERW) is also sitting on the volcanic range of *Las Cruces*, covering an area of 2301 ha where farming and husbandry are common livelihood activities. The most important water system is the Eslava River, which is 13 km long and joins the *Magdalena* River at its urban section. Forest plant communities, dominated by oak and pine, occupy 71% of the ERW with almost 52% of the territory being forested (Fernández-Eguiarte et al., 2004). The watershed faces problems such as soil degradation, erosion, water pollution, unauthorized housing settlements and land use change, among others.

Most of the ERW land belongs to the *ejido San Nicolás* (1984 ha), which counts with 340 formal right holders (Schteingart and Salazar, 2005). It was founded in 1924 through a collective land ownership arrangement and an assembly that meets monthly governs it. Promoted by the *ejido* authorities and the assembly, the protected area of *Parque Ejidal San Nicolás Totolapan* (1300 ha) was established in 1997 within the *ejido* boundaries in order to curtail urban growth, preserve forests, and create local job opportunities based on tourism and rural products, thus reflecting the *ejido*'s commitment to conservation (Miranda-Zambrano, 2008).

Since 2003, both *Magdalena* and *San Nicolás* have participated in the PSAH, allocating 1362.89 and 1095.12 ha under the program, respectively. In 2008, they renewed their involvement; *Magdalena* increased the area covered to 1450.49 ha and *San Nicolás* increased it to 1319.87 ha. Since 2009, *San Nicolás* has been involved in other state and federal forest management programs, which have provided funds for plantation-based reforestation activities in an additional area of 387 ha. In both communities, PSAH participation requires: (1) limiting extensive grazing, in order to favour natural regrowth and to prevent soil compacting; (2) establishing brigades to prevent wildfires, forest pests, illegal logging, poaching and/or fauna and flora extraction; and (3) putting up and maintaining signs to identify the PSAH supported areas. Additionally, the community/*ejido* should hold at least one workshop to inform all residents (formal and non-formal right holders) about PSAH goals (DOF, 2008).

Surveys and focus groups

We conducted intermittent fieldwork in *Magdalena* and *San Nicolás* between 2010 and 2012 to document perceptions on local ecosystem services and the effectiveness of the PSAH program. Questionnaire design was guided by the Sustainable Livelihood Approach (SLA) (DFID, 1999) to characterize households and livelihood conditions, and to highlight perceptions over the implementation of the PSAH and of locally provided ecosystem services more generally. The questionnaire was adapted to reveal differences between communities and was divided into three sections concerning personal data and household composition; perception over and use of ecosystem services; and specific questions related to the PSAH program.

Our reference population for survey development in both communities were formal right holders. They are those who control the assembly, manage and most commonly use the forest, and are legally entitled to receive a share of PSAH payments – unless the community assembly decides otherwise. Due to time and resource constraints, we achieved a sampling intensity of 10% in each community, and we were able to survey 41 randomly selected right holders from *Magdalena* and 31 from *San Nicolás*. Surveys were posed indistinctively to male or female household heads in order to determine if gender had an influence on PSAH perception. The pollster informed about the survey aims; emphasized that participation was voluntary and anonymous; that the respondent could choose not to answer uncomfortable questions; and that collected data would only be used for writing an academic article. Surveys lasted between 45 and 60 min.

We complemented the surveys with one focus group in *Magdalena* and another in *San Nicolás*, both involving five people. The community/*ejido* assembly selected the focus group participants, which constitutes a research caveat since the views from focus groups were presumably those of who were more supportive of PSAH activities and were better informed. The focus groups helped us to explore participants' knowledge about PSAH in further detail, the contribution of the latter to household and community wellbeing, the environmental benefits resulting from participating in the program, and the challenges experienced when developing PSAH activities. During the focus group, we asked participants to respond to each question and construct a collective, consensus-based answer. Discussions were recorded and transcribed for analysis in order to draw a comparison between the answers provided by the randomly surveyed participants and the focus group (Table 1).

Table 1
Key issues explored through the household survey and the focus group exercises.

The household survey	
Personal household (HH) data	Number of household members Education levels Income-gain strategies Engagement in community governance
Perception over and use of ecosystem services	Use of river and piped water Perception of local water quality/quantity Use of forest resources perception of land-cover change in recent years
PSAH program	Knowledge about PSAH & related activities at community level Amount of and use of payments received by the community and/or HH Importance of the payment for the HH Participation in PSAH meetings and ecosystem management activities
The focus group exercises	
PES program knowledge	Initiative and decision to participate Knowledge and enforcement of mandatory and complementary activities Payment and influence in forest management
Monitoring and enforcement activities	How and who selected participants to carry out activities of PES Who verifies that PSAH activities are carried out External and internal sanctions for failing to perform the activities Changes in land-use and forests that can be attributed to PES program
Wellbeing	Creation and performance of organized groups to improve forest management Economic, social and environmental community welfare (enhancements in the forest and the river quality and quantity) Distribution and payment accountability Participation in other conservation programs
Peri-urban pressures and conservation dynamics	Key drivers of land-use change Influence of PSAH activities on these drivers Overlap of PSAH with the SfC program Considerations on future land-use once PSAH ends

Results

Household characteristics

The average respondents' age in both communities was above 50 years old and most of the surveyed individuals were male (71% in *Magdalena* and 68% in *San Nicolás*). This is consistent with the gendered distribution of formal land rights in Mexican communities and *ejidos*, in which women only hold 25.8% of legal property according to recent official statistics (Deere and León, 2001; SEDATU, 2012). Participants in focus groups were also male, allegedly because PSAH activities are strenuous and the management and conservation of standing trees are culturally conceived as men-led activities. *San Nicolás* shows a higher percentage of people cultivating land within the *ejido* boundaries (87%) than *Magdalena*'s (44%). However, farming and forestry activities are performed as secondary livelihood activities in both communities since most people have a job or work in the city and they are thus a support for household consumption or a source of additional income. Nearly 10% of both community members have no schooling, but most of its inhabitants hold a primary and secondary school degree (66%). In *San Nicolás*, 16% of the interviewees held a university degree. Several working groups were established after the PSAH program in order to support its objectives. For example, brigades to prevent wildfires and monitor the PSAH area for illegal logging have been established in both communities, with a different degree of cohesion and organization.

Respondents' dependence on local natural resources is shown in Table 2. Interviewees in *Magdalena* perceived the river ecological system as a critical natural asset that conveys scenic beauty and attracts tourists to local restaurants. Agricultural activities, which are often irrigated, involve maize, beans, potatoes and courgette cultivation, accompanied by the collection of non-timber forest products, such as mushrooms, medicinal plants, and the hunting of wild animals. Husbandry includes cows and deer rising. In *San Nicolás* interviewees had a more limited use of water resources compared to *Magdalena*'s since the tourism component was less relevant; water is mainly used for irrigating crops and supporting cattle and fish farming. Forest products, such as timber and firewood are somewhat also less recognized because individuals stated that such activities are illegal in SfC areas. Nevertheless, seven respondents from *Magdalena* and eight from *San Nicolás* recognized extracting a variety of timber species.

Interviewees from *Magdalena* argued that the community's consumption of river water had decreased over the years because of increasing pollution and their current access to piped water. Most river water consumption is thus actually related to trout farming and restaurant activities. Participants in the *San Nicolás* focus group emphasized that their river was less relevant for tourism purposes than in *Magdalena* because it carries smaller water volumes and it is shorter in length, with intermittent sections. Both focus group participants, however, mentioned that forest management activities are severely constrained by the SfC program rules, which have enacted a logging ban and, subsequently, have made the forest more prone to plagues and wildfires. As highlighted by one of our interviewees: "CONAFOR does not give us permits to extract firewood or timber. There are several spreading plagues in the forest and we also need permission to remove the dead trees" (*Magdalena*'s farmer, our translation).

Understanding and benefiting from PSAH

Ninety one per cent of respondents in *Magdalena* noted that PSAH mandatory activities were performed effectively, whilst in *San Nicolás* only 41% of respondents shared such perspective. In contrast, all focus group participants in both communities noted that mandatory activities were implemented, probably because such participants were closer to the authorities and had been selected to participate in PSAH activities. However, when they were asked to name such activities, they were unable to do so. It is also relevant to highlight that only one third of *San Nicolás* respondents and only half of those in *Magdalena* were aware of the existence of the PSAH program, even if most of them attended the assembly. Among those who stated familiarity with the PSAH program, results reveal an uneven level of knowledge concerning program objectives and activities on-site. For example, a substantial share of surveyed community members (35% in *Magdalena* and 54% in *San Nicolás*) was not aware that the PSAH program funding supports reforestation activities taking place in the designated areas.

The focus group in *Magdalena* reported that local authorities decide on who works in PSAH activities through informal meetings and participants tend to be those who are closer to such

Table 2
Socio-economic background in both communities and direct uses of their natural resources.

Demographic variable	Magdalena $N=41$	San Nicolás $N=31$
Household head interviewed		
Female	29%	32%
Male	71%	68%
Respondent's education level		
None	10%	9%
Primary schooling	51%	44%
Secondary schooling	15%	22%
High school	17%	9%
University degree	7%	16%
Average number of monthly assemblies attended per year	8	10
Average number of household members	7	8
Work/cultivate land for self-consumption or profit (%)	44%	87%
Participation in fire watch brigades	27%	14%
Communities' direct uses of their natural resources in both communities		
Respondents who declared using water from the river[a]	90%	87%
River water uses (% over the sample)		
For drinking	15%	7%
Crop irrigation	10%	11%
Cattle	4%	10%
Fish farming	14%	10%
Domestic use	19%	5%
Restaurants	12%	3%
Tourist attraction	31%	0
Respondents who declared obtaining benefits such as		
Forest products (timber, firewood)	7%	8%
Non timber forest products (e.g. mushrooms, medicinal plants, wild animals)	28%	10%
Agricultural activities (maize, beans, potatoes cultivation)	21%	12%
Husbandry (trout fish, cows, deer)	26%	23%

[a] Multiple answers were possible.

authorities. In *San Nicolás*, the assembly decides who should get involved in the forestry activities undertaken (i.e. forest conservation and patrolling, reforestation). Information provided by the focus groups also revealed that workers' selection depends on the number of activities and work needed, as well as the money available for payments and the number of interested right-holders. Around 20 men have been chosen to participate in such activities every year in each community, which as we highlight later has been in some cases controversially perceived by those excluded.

Both communities are aware that CONAFOR can withhold payments if they do not perform PSAH activities. To date, however, no CONAFOR officer has visited *Magdalena* for evaluative purposes while *San Nicolás* has only been visited once. Finally, the focus group in *San Nicolás* stated that the *ejido* had raised additional funds to carry out forest conservation activities by participating in other government programs such as CONAFOR's Christmas tree plantations and deer ranching programs. This situation contrasted with *Magdalena*, where focus group participants were not aware of additional funding programs and criticized CONAFOR for performing poorly and not visiting the community to advise them properly on PSAH or other *ProÁrbol* programs.

We have shown elsewhere that income levels, livelihood dependence on the river flow, education levels and participation in general assembly are positively correlated with people's knowledge about PSAH (Neitzel et al., 2014). In this paper, we can further qualitatively infer that lack of awareness about the existence of the PSAH or its related land-use activities can also be explained by insufficient information sharing at community level. In *Magdalena*, for example, the implementation of PSAH activities is planned on an *ad-hoc* basis, and very often in meetings outside the assembly. As noted above, and according to our respondents, a common practice is that authorities call some people to undertake PSAH activities and in exchange they are offered MXN $250 (US $19.5) per day, a figure that matches with the answer provided by some of the surveyed individuals when asked how much money they received from the program (67%). This is of course inaccurate, since such payment only corresponds to the internal daily labour wage for community activities as pre-defined by the assembly. Subsequently, authorities should spend the remaining funds in equal shares among right holders who attend the community assembly but in practice this does not always happen. When prompted about how much money did the authorities kept for even sharing, our survey respondents did not know and the focus group respondents declined to answer.

In *San Nicolás*, authorities manage a fund that pools together funding from various programs and projects (including PSAH). Authorities pay daily wages to those participating in forest patrolling and conservation activities and distribute MXN$2000 (US$154) every year to right holders, which represents 5–10% of respondents' annual income. Since this is paid in one instalment at the end of the year, respondents considered it a Christmas bonus gift. In 2011 and 2012 they received MXN $5000 (USD $385) from all the pooled funding, including PSAH. In Magdalena, the payment was sensibly lower due to a larger population (average MXN$2000 per year (US$154), i.e. less than in *San Nicolás*).

We have not gathered data on income from farming activities, nor from illegal activities conducted in forests located within or outside PSAH targeted areas and subject to the SfC program regulations. There is thus not official data on the economic benefits derived from logging in the area or from illegal urban developments. However, Neitzel's (2013) recent economic study in the same region where San Nicolás and Magdalena are located suggests that net benefits might be of approximately $12,055 Mexican pesos per ha/year (US$ 911) for farmlands and $15,675 Mexican pesos per ha (US$ 1185) for forestland sold to urbanization purposes. These figures reflect the potential level of obtainable income from both villages' forests – provided soil and slope conditions allow –, which are higher than in other marginalized rural areas where the PSAH mostly operates (Perevochtchikova and Vázquez, 2012).

Perception of ecosystems services and effects of PSAH on land use change

Respondents' perceptions on ecosystem services were not limited to the scope of the PSAH program but related broadly to the watershed socio-ecological system, and particularly to the role of their standing forests in rural–urban interactions. For example, focus group respondents in *San Nicolás* were able to articulate a discourse in which, on the one hand, they argued that their forests were sustaining critical ecosystem functions, such as groundwater recharge and oxygen provision whilst, on the other, they highlighted that it was unfair to be taking care of the forests for such little money while urban sprawl continued. In *Magdalena*, focus group participants also argued that their standing forests are critical to provide oxygen and water to the city:

> "The SfC and PSAH programs are designed so that we all can have oxygen and water. We are the city lungs. We own this land but at the same time we do not [because of the programs' restrictions on land-use]. However, we are working hard to keep the city going. . ." (*Magdalena*'s farmer, our translation).

Survey respondents generally perceived that the PSAH program was not contributing to significantly conserve or expand forested areas, but only to slow down the process of illegal deforestation and urban development. A majority in both communities considered that forest cover had decreased in the last seven years and only a quarter perceived an increase in forest cover (Table 3). As hinted above, recent studies confirm this trend: the current rate of urban expansion around Mexico DF is approximately 350 ha/year with a deforestation rate of around 240 ha/year (SEMARNAT, GDF, CORENA and DEOE, 2000). Both focus groups confirmed the rapid expansion of settlements in recent years and the government's inability to halt the process.

Additionally, survey respondents in *San Nicolás* and *Magdalena* (83% and 85%, respectively) argued that the amount of river flow had decreased over the last two decades, due to an increase in water extraction and forest loss. There was also a perceived ideal relationship between an increase in forest cover with water quality (75% and 70%, respectively) and with water quantity (75% and 80%, respectively). In *San Nicolás*, 68% of surveyed respondents believed that reforestation aided in water infiltration whilst in *Magdalena* such causal relationship was only mentioned by 32% of the interviewees.

In both communities, individuals noted that they did not have any plans for the land enrolled in PSAH once it ends (23 from *Magdalena* and 11 from *San Nicolás*). Nevertheless, fieldwork insights revealed that the intention to preserve the forest once the program has finished was greater in *Magdalena* than in *San Nicolás* because farming and husbandry activities were more prevalent in the latter and there was a general vested interest in maximizing revenue from agricultural activities. Participants in both focus groups noted that they were in favour of forest conservation and requested continuous financial support to do so. Furthermore, they also mentioned the need to reform the SfC and PSAH rules so that local forests can be actively managed and illegal logging and urban settlements could be deterred through the indirect increase in forest resources' profitability. As a local authority suggested:

> "To get the forest back to its state 20 years ago we need further technical and economic support. If the logging ban was lifted we could be trained to better manage the forests and extract timber. We live in the forests and we see things differently than sitting by a desk. We also need to be able to extract dead trees because

Table 3
Individuals' perceptions on the PSAH program for forest conservation and water benefits.

Perceptions on the PSAH program	Magdalena community $N=41$	San Nicolás community $N=31$
Awareness of the PSAH program[a]	51% ($n=21$)	35% ($n=12$)
Average monthly income range per household	MXN$1701–$3400 (US$262)	MXN$1701–$3400 (US$262)
Correctly named institution in charge of payments	40%	0%
Compliance with mandatory activities		
Activities resulting from participation in PES program		
None/do not know	32%	68%
Reforestation and gavion dam	68%	32%
Response to survey question		
Perception of change in forest cover area under PES program (last seven years) (%)		
Increased	25%	23%
Decreased	57.5%	56%
Remained the same	17.5%	21%
Perception that an increase in forest cover is associated with an increase in water quality	70%	75%
Perception that the forest would be preserved without PES program	65%	57%
Expected land use in PSAH area when funding support ends[b]:		
Forest conservation	24%	13%
Agriculture	14.6%	19%
Cattle	0%	22.6%
Housing	4.8%	9.7
Do not know	56%	35.5%
Perception that an increase in forest cover is associated with an increase in water supply (quantity)	80%	75%
Awareness of possible depletion of the river water supply	85%	83%

[a] Values below refer to the group of individuals stating awareness about the communities' participation in the PSAH program.
[b] Multiple answers were possible.

they are impeding seed germination and forest renewal" (*San Nicolás'* farmer, our translation).

Discussion

PES has gained momentum in ecosystem management policies as a tool to achieving conservation goals while contributing to resource managers' wellbeing. PSAH implementation in our two studied communities has somewhat proceeded over the past six years without a careful evaluation on behalf of CONAFOR, at least regarding environmental effectiveness and PSAH contribution to local socio-economic and organizational development. Our results suggest that PSAH, even when combined with an underlying conservation program such as CfS, result insufficient in halting land-use change from urban sprawl at a landscape level (see also Perevochtchikova and Vázquez Beltrán, 2012). PSAH activities have been unable to avoid the increasing activity of local restaurants and illegal settlements that extract and pollute local water sources. This somehow falls out of the scope of the PSAH program's objective but highlights the importance of coordinating policy programs to secure the provision of multiple ecosystem services, since forest conservation and management alone are unlikely to guarantee sustainable practices in other resource domains, such as water courses and agricultural lands.

Both communities have been able to renew and even expand their participation in PSAH since the targeted areas have been somewhat protected and neighbouring leakage effects are not assessed or accounted for by CONAFOR when approving the renewal of the five-year payment period. This finding is not surprising since research has already indicated the risks embedded in national PES programs, including a lack of effective monitoring of compliance and environmental additionality and the political costs involved in sanctioning non-compliance (Pattayanka et al., 2010). In this particular context, our results also demonstrate that addressing land-use change in rural–urban fringes is a challenging task (Perevochtchikova and Vázquez Beltrán, 2012). PES programs alone may not resolve the urban encroachment problem, even if payments would be increased to cover the opportunity costs of land in such contexts. Urban–rural dynamics in Mexico DF (and in other mega-cities) are inextricably linked to urban growth and economic development processes, resulting in an increasing appropriation and degradation of natural ecosystems around and within the metropolis core. These impacts can only be minimized and addressed through a process of legitimate, enforceable and effective land-use governance, steered by the government and involving all administrative levels and relevant actors, including surrounding communities and all those who contribute both legally and illegally to the process (Aguilar and Santos, 2011).

In our study, we have shown that in both communities, authorities and interviewees are mostly willing to support conservation for cultural and historical reasons, as documented elsewhere in the country (Alix-Garcia et al., 2010), but there are also clear indications that other residents participate in or facilitate the appropriation of land and forest resources by other external actors and for other purposes. Both *Magdalena* and *San Nicolás* welcome the rights and duties involved in managing the forests for CfS and PSAH but claim for more political influence in crafting program rules. Such willingness and constructive criticism should be regarded by Mexico DF planners as an enabling factor easing communities' involvement in any future attempt to regulate urban sprawl, as far as such attempt comes accompanied by new institutional arrangements involving adequate and negotiated compensations for those who still live off the city's surrounding forests and agricultural landscapes.

Magdalena and San Nicolás also show an uneven level of understanding of the PSAH scheme, which is a common finding across other PES programs in Mexico and elsewhere, and particularly when incentives are pooled together and perceived as yet another "government subsidy" (Wunder et al., 2008; Corbera et al., 2009; Rico García-Amado et al., 2011). This is due to the fact that both communities differ in population size and livelihood characteristics, which also explain distinct organizational community arrangements and response to the PSAH. In *Magdalena*, the population is larger and their dependence on agriculture and forestry activities has progressively diminished over the past two decades. Less than one quarter of formal right holders participates in assembly meetings, and authorities find it difficult (or are unwilling) to involve all of them in forest conservation activities. Subsequently, information on PSAH remains concentrated in a few people and benefits are also skewed towards a minority of right holders. This process could be somehow understood as a process of elite capture (see e.g. McAfee and Shapiro, 2010; Pattayanka et al., 2010), but we do not have sufficient data to assert whether it is either 'malevolent' or 'benevolent'

capture, i.e. the extent to which such PSAH revenue management strategy is accepted or challenged by those who decide to not participate in assemblies and on which grounds they do so.

In contrast, in *San Nicolás*, the population is five times smaller than *Magdalena*'s and their interest in forest conservation activities dates back to the mid 1990s when they created the local conservation area. This has translated in a higher level of social organization for forest management and further attention to available forest management programs, including PSAH (Neitzel et al., 2014). Again, we cannot assert if community authorities appropriate or mismanage the pool of funds generated by government programs but we can suggest that resources seem more evenly distributed across participants in forest brigades and across the rest of households.

Education levels and forest management knowledge and capacity also explain uneven levels of PSAH understanding (Neitzel et al., 2014). *San Nicolás* counts, on average, with a higher schooling level across right holders and their previous engagement with forest conservation issues has meant that local community groups promoting agricultural activities and eco-tourism projects in the local conservation area are already well-established, which has in turn enabled them to access more resources for land management activities from diverse sources (Miranda-Zambrano, 2008). Focus group members and surveyed right holders in *San Nicolás* recognized the linkage between forest services, water flows and Mexico DF's development whilst people in Magdalena were somewhat unclear about such relationship. In Magdalena, PSAH activities were considered a "one-off" job that is rarely related to the PSAH long-term logic of conserving forests presently and in the future. In this regard, our data – corroborated by Neitzel (2013) – reveals that households with higher income levels perceive the program as an additional income source to their regular jobs, whilst the poorest households also consider it a potential threat to their forest-related activities, particularly (illegal) timber extraction. This reveals that the PSAH, and PES more generally, can be perceived and felt unevenly in large communities, where livelihoods are often heterogeneous and income disparities exist.

In both communities, PSAH activities are regarded as a male-driven activity, and women's participation in brigades or decisions regarding funds management is almost non-existent. This also goes in line with other reported cases, in which government programs are targeted to legitimate landowners, who in most Latin American countries are male (Asquith et al., 2008; Pagiola, 2008; Muñoz-Piña et al., 2008). Gender equity is thus overlooked in many PES government programs since it is very often perceived that aiming to involve women in PES design and implementation would be going against local culture and politics (Corbera et al., 2007b). But attention to gender in PES research should not only involve an analysis of women's degree of involvement and derived benefits but more importantly the implications of PES activities on the distribution of household tasks, on changing patterns of resource and income access, and time use across household members as a result of PES activities, as well as on the potential role of women in fostering (or not) a better and more equitable performance of PES schemes. This remains a rather unexplored area in PES studies, which contrasts with the long-standing gender emphasis in other rural policy domains, such as agricultural development or forest management (see, e.g. Rocheleau and Edmunds, 1997; Mwangi et al., 2011).

The ability of the PSAH program to rely on well-established local organizational dynamics to ensure compliance and local stewardship in these rural–urban contexts – and other regions – may be increasingly jeopardized by the out-migration of young generations and by the increasing diversification of household activities that in some cases can lead to reduced labour and time investments in collective action (Mutersbaugh, 2002). Global change processes are proceeding fast and many community-based institutions, such as traditional resource management knowledge systems, are finding it challenging to adapt, often hybridizing into other forms of knowledge and collective organization (Gómez-Baggethun et al., 2013). PSAH and other PES and rural development programs in Mexico and elsewhere will also have to adjust to these changing circumstances by, for example, dedicating more funds to individual and collective training on forest management and to developing programs that secure conservation whilst facilitating access to income or services from protected forests that can result attractive to younger generations, in line with sustainably managed commons and indigenous conservation areas.

In the case of the two studied communities, we would urge CONAFOR and Mexico DF authorities to negotiate with local communities an amendment of PSAH and CfS rules to allow the development of sustainable forest management plans, which can create local jobs and lead to certified timber forest products. These actions would need to be accompanied by increased training of interested community members and more PSAH informative workshops; monitoring of local forest management activities and leakage accounting through on-the-ground, community-led assessments; and by increasing the accountability of local communities, regarding the participation of both right and non-right holders, information-sharing and a more transparent management of PSAH funds by local authorities. Additionally, and in line with other scholars (Aguilar and Santos, 2011), we urge the federal and city governments to tackle urban sprawl with existing legal provisions and explore the design of new institutions that can transfer funds from private urban developers to PSAH-involved communities around Mexico DF. This would mirror conservation policy developments in many EU countries and it would allow – not without legal, technical and ethical complexities and controversies – the mobilization of funds from the private sector to rural communities that provide critical ecosystem services to nearby urban areas (Grolleau and McCann, 2012). In pursuing these suggested reforms, CONAFOR and related administrations could gain from the advice of intermediary organizations, such as those that already act as PSAH service providers in Mexico, as well as other well-established NGOs that have supported community forestry or small-scale pilot PES schemes. Recent research shows that the presence of external organizations in forest management programs reinforces local organization and avoids or reduces elite capture (Persha and Andersson, 2014).

Conclusions

Public policies and incentive-based programs to support biodiversity and land-use governance in developing countries, such as (community-based) protected areas, integrated conservation and development programs and more recently PES schemes, have proliferated and have increasingly interacted and overlapped over the last two decades. The environmental effectiveness of each of these instruments varies across typology, context and country. In Mexico, the development of large government-driven PES programs during the mid-2000s has supported other existing forest management programs and expanded the country's area under some form of conservation arrangement.

In this article, we have looked at the implementation of the PSAH program in two communities located in the rural–urban fringe of Mexico City. There are dozens of communities receiving PSAH payments around this and other large cities in the country but very few have received research attention in the emerging PES scholar community. We have thus shed light on the additional challenges involved in parachuting conservation incentives in areas of very high land opportunity costs. We have shown that if such incentives reinforce an existing command-and-control measure, such as the CfS program, they can be somewhat effective in guaranteeing conservation in the targeted area, but they fail to induce additional

conservation in surrounding and more degraded lands. This can be explained by the livelihood profile of a large share of inhabitants, who work mostly in the city, are not explicitly interested in conservation and have high economic incentives to circumvent land-use regulations. The fact that the PSAH program is unable to dedicate sufficient resources for training and monitoring all supported *ejidos*/communities translates also into a lack of knowledge about program rules and of transparency in funds' management. On a more positive note, however, our analysis has highlighted that PSAH funds (partly) arrive to all households, thus contributing to increase their gross income, and are particularly welcomed by formal right holders. Seemingly, the PSAH program has contributed to strengthen existing forest management groups and on-going local conservation initiatives.

Overall, we have argued for the development of differentiated PES programs that are specifically targeted to the reality and dynamics of rural–urban fringes. These programs should involve city and metropolitan actors that indirectly impact on or have an interest in the long-term conservation of agricultural land and ecosystems. They should establish sustainable and fair funding mechanisms that offer higher and more conditional rewards to landowners whilst supporting and contributing to enforce or change any existing land-use regulations to better fit the needs and aspirations of local populations and their own conservation ethos. Transforming megacities, such as Mexico DF, into liveable urban environments may depend on how successful we are in this regard.

References

Aguilar, A.G., Lopez-Guerrero, F., 2013. Poverty in peripheral informal settlements in Mexico City: the case of Magdalena Contreras, Federal District. Tijdschrift voor Economische en Sociale Geografie 104, 359–378, http://dx.doi.org/10.1111/tesg.12012.

Aguilar, A.G., Santos, C., 2011. Informal settlements' needs and environmental conservation in Mexico City: an unsolved challenge for land-use policy. Land Use Policy 28, 649–662, http://dx.doi.org/10.1016/j.landusepol.2010.11.002.

Alix-Garcia, J.M., Shapiro, E.N., Sims, K.R.E., 2010. The environmental effectiveness of payments for ecosystem services in Mexico: Preliminary lessons for REDD. Draft Paper. Department of Agriculture and Applied Economic, University of Wisconsin, Madison.

Alix-Garcia, J.M., Shapiro, E.N., Sims, K.R.E., 2012. Forest conservation and slippage: evidence from Mexico's National Payments for Ecosystem Services Program. Land Econ. 88 (4), 613–638.

Allen, A., Dávila, J.D., Hofmann, P., 2006. The peri-urban water poor: citizens or consumers? Environ. Urban. 18, 333–351, http://dx.doi.org/10.1177/0956247806069608.

Asquith, N.M., Vargas, M.T., Wunder, S., 2008. Selling two environmental services: in kind payments for bird habitat and watershed protection in Los Negros, Bolivia. Ecol. Econ. 65, 675–684, http://dx.doi.org/10.1016/j.ecolecon.2007.12.014.

Bolund, P., Hunhammar, S., 1999. Ecosystem services in urban areas. Ecol. Econ. 29, 293–301.

Costanza, R., D'Arge, R., De Groot, R.S., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Nelly, R.V., Paruelo, J., Raskin, R.G., Sutton, P., Van den Belt, M., 1997. The value of the World's ecosystem services and natural capital. Nature 387, 253–260.

Corbera, E., Kosoy, N., Martinez-Tuna, M., 2007a. Equity implications of marketing ecosystem services in protect areas and rural communities: case studies from Meso-America. Global Environ. Chang. 17, 365–380, http://dx.doi.org/10.1016/j.gloenvcha.2006.12.005.

Corbera, E., Brown, K., Adger, W.N., 2007b. The equity and legitimacy of markets for ecosystem services. Dev. Chang. 38 (4), 587–613, http://dx.doi.org/10.1111/j.1467-7660.2007.00425.

Corbera, E., Gonzáles-Soreranis, C., Brown, K., 2009. Institutional dimensions of payments for ecosystem services: an analysis of Mexico's carbon forestry programme. Ecol. Econ. 68, 743–761, http://dx.doi.org/10.1016/j.ecolecon.2008.06.008.

Cortina-Villar, S., Plascencia-Vargas, H., Vaca, R., Schroth, G., Zepeda, Y., Soto-Pinto, L., Nahed-Toral, J., 2012. Resolving the conflict between ecosystem protection and land use in protected areas of the Sierra Madre de Chiapas, Mexico. Environ. Manage. 49, 649–662, http://dx.doi.org/10.1007/s00267-011-9799-9.

Daily, G.C. (Ed.), 1997. Nature's Services. Societal Dependence on Natural Ecosystems. Island Press. EUA, p. 392, http://dx.doi.org/10.1017/S1367943098221123.

de Koning, F., Aguinaga, M., Bravo, M., Chiu, M., Lascano, M., Lozada, T., Suarez, L., 2011. Bridging the gap between forest conservation and poverty alleviation: the Ecuadorian Socio Bosque program. Environ. Sci. Soc. 14, 531–542.

Deere, C., León, M., 2001. Who owns the land? Gender and land-titling programmes in Latin America. J. Agrar. Change 1 (3), 440–467, http://dx.doi.org/10.1111/1471-0366.00013.

Díaz-Caravantes, R., Sánchez-Flores, E., 2011. Water transfer effects on peri-urban land use/land cover: a case study in a semi-arid region of Mexico. Appl. Geogr. 31, 413–425.

Dobler, C.E., (Biology grade thesis. Science Faculty) 2010. Caracterización del clima y su relación con la distribución de la vegetación en el suroeste del D.F., México. UNAM, México.

DFID, 1999. Sustainable livelihoods guidance sheets, Guidance Sheets 1–7. Department for International Development.

DOF (Diario Oficial de la Federación), 2008. Términos de referencia para la elaboración del programa de mejores prácticas de manejo de conformidad al acuerdo por el que se expiden las reglas de operación del programa pro-árbol de la Comisión Nacional Forestal. 16 de enero de 2008.

DOF, 2010. Reglas de operación del programa ProArbol 2010. 29 de diciembre de 2010. Diario Oficial de la Federación, Available at: http://dof.gob.mx/nota_detalle.php?codigo=5172994&fecha=29/12/2010

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecol. Econ. 65, 663–674, http://dx.doi.org/10.1016/j.ecolecon.2008.03.011.

Fernández-Eguiarte, A., Vasquéz-Márquez, A., Uribe-Cruz, F., Bustillos-Herrera, J., Aguilar-Velazco, H., Juárez Pérez, M., Apolina, B., Ramírez del Razo, I., Lopéz-Sánchez, R., Islas-Rodríguez, M., Vera-Figueroa, J.J., 2004. Ecoturismo y desarrollo económico en la delegación la *Magdalena* Contreras, Distrito Federal. Gac. Ecol. 70, 67–76.

Figueroa, F., Sánchez-Cordero, V., 2008. Effectiveness of natural protected areas to prevent land use and land cover change in Mexico. Biodivers. Conserv. 17, 3223–3240, http://dx.doi.org/10.1007/s10531-008-9423-3.

Gómez-Baggethun, E., de Groot, R., Lomas, P.L., Montes, C., 2010. The history of ecosystem services in economic theory and practice: from early notions to markets and payments schemes. Ecol. Econ. 69, 1209–1218, http://dx.doi.org/10.1016/j.ecolecon.2009.11.007.

Gómez-Baggethun, E., Corbera, E., Reyes-García, V., 2013. Traditional ecological knowledge and global environmental change: research findings and policy implications. Ecol. Soc. 18 (4), 72, http://dx.doi.org/10.5751/ES-06288-180472.

Grolleau, G., McCann, L.M.J., 2012. Designing watershed programs to pay farmers for water quality services: case studies of Munich and New York City. Ecol. Econ. 76, 87–94, http://dx.doi.org/10.1016/j.ecolecon.2012.02.006.

Gutman, P., 2007. Ecosystem services: foundations for a new rural–urban compact. Ecol. Econ. 62, 383–387, http://dx.doi.org/10.1016/j.ecolecon.2007.02.027.

Haregeweyn, N., Fikadu, G., Rsunekawa, A., Tsubo, M., Tsegaye Meshesha, D., 2012. The dynamics of urban expansion and its impacts on land use/land cover change and small-scale farmers living near the urban fringe: a case study of Bahir Darm Ethiopia. Lands. Urban Plan. 106, 149–157.

INEGI (Instituto Nacional de Estadística y Geografía), 2011. Resultados preliminares del censo de población y vivienda 2010. www.censo2010.org.mx (accessed 26.10.11).

Inostroza, L., Baur, R., Csaplovics, E., 2013. Urban sprawl and fragmentation in Latin America: a dynamic quantification and characterization of spatial patterns. J. Environ. Manag. 115 (30), 87–97.

Jujnovsky, J., Almeida-Leñero, L., Bojorge-García, M., Monges, Y.L., Cantoral-Uriza, E., Mazari-Hiriart, M., 2010. Hidrologic ecosystem services: water quality and quantity in the *Magdalena* river, México city. Hidrobiológica 20, 117–213.

Kroll, F., Müller, F., Haase, D., Fohrer, N., 2012. Rural–urban gradient analysis of ecosystem services supply and demand dynamics. Land Use Policy 29, 521–535, http://dx.doi.org/10.1016/j.landusepol.2011.07.008.

Kosoy, N., Corbera, E., 2010. Payments for ecosystem services as commodity fetishism. Ecol. Econ. 69, 1228–1236, http://dx.doi.org/10.1016/j.ecolecon.2009.11.002.

Martínez rivera, S.E., Monroy-Ortiz, R., 2009. La expansión urbana sobre el campo mexicano. La otra cara de la crísis agrícola. Revis. Estud. Agrar., 29.

McAfee, K., Shapiro, E.N., 2010. Payment for ecosystem services in Mexico: nature, neoliberalism, social movements and the state. Ann. Assoc. Am. Geogr. 100 (3), 579–599, http://dx.doi.org/10.1080/00045601003794833.

MEA (Millennium Ecosystem Assessment), 2005. Ecosystems and Human Well-being. Island Press, Washington, DC.

Miranda-Zambrano, G., (PhD thesis) 2008. El conocimiento tradicional y la propuesta de educación y cultura ambiental en la gestión integral ecoturística del parque *San Nicolás* Totolapan, Ciudad de México. Universidad Autónoma Metropolitana.

Miteva, D., Pattanayak, S.K., Ferraro, P.J., 2012. Evaluation of biodiversity policy instruments: what works and what doesn't? Oxford Rev. Econ. Pol. 28 (1), 69–92, http://dx.doi.org/10.1093/oxrep/grs009.

Muñoz-Piña, C.A., Guevara, A., Torres, J.M., Braña, J., 2008. Paying for the hydrological services of Mexico's forest: analysis, negotiations and results. Ecol. Econ. 65, 725–736.

Muradian, R., 2013. Payments for ecosystem services as incentives for collective action. Soc. Nat. Resour. 26 (10), 1155–1169.

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. Ecol. Econ. 69, 1202–1208, http://dx.doi.org/10.1016/j.ecolecon.2009.11.006.

Mutersbaugh, T., 2002. Migration, common property, and communal labor: cultural politics and agency in a Mexican village. Polit. Geogr. 21, 473–494, http://dx.doi.org/10.1016/S0962-6298(01)00081-6.

Mwangi, E., Meinzen-Dick, R., Sun, Y., 2011. Gender and sustainable forest management in East Africa and Latin America. Ecol. Soc. 16 (1), 17 http://www.ecologyandsociety.org/vol16/iss1/art17/

Navarrete, J.-L., Ramírez, M.I., Pérez-Salicrup, D.R., 2011. Logging within protected areas: spatial evaluation of the monarch butterfly biosphere reserve, Mexico. Forest Ecol. Manag. 262, 646–654, http://dx.doi.org/10.1016/j.foreco.2011.04.033.

Neitzel, K.C., (PhD thesis) 2013. Payments for environmental services – reducing emissions from deforestation and degradation (PES-REDD) in Mexico: a strategy to guarantee the permanence of forest carbon stocks? Posgrado en Economía, economía de los recursos naturales y desarrollo sustentable, Universidad Nacional Autónoma de México (UNAM), México.

Neitzel, K.C., Caro-Borrero, A.P., Revollo-Fernández, D., Aguilar-Ibarra, A., Ramos, A., Almeida-Leñero, L., 2014. Paying for environmental services: determining recognized participation under common property in a peri-urban context. Forest Policy Econ. 38, 46–55, http://dx.doi.org/10.1016/j.forpol.2013.04.002.

Niemelä, J., Saarela, S.R., Söderman, T., Kopperoinen, L., Yli-Pelkonen, V., Väre, S., Kotze, D.J., 2010. Using the ecosystem services approach for better planning and conservation of urban green spaces: a Finland case study. Biodivers. Conserv. 19, 3225–3243, http://dx.doi.org/10.1007/s10531-010-9888-8.

Pagiola, S., 2008. Payments for environmental services in Costa Rica. Ecol. Econ. 65, 712–724.

Pagiola, S., Arcenas, A., Platais, G., 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and evidence to date from Latin America. World Dev. 33, 237–253, http://dx.doi.org/10.1016/j.worlddev.2004.07.011.

Pagiola, S., Platais, G.,2002. Market-based mechanisms for conservation and development: the simple logic of payments for environmental services. In: Environmental Matters – Annual Review, July 2001–June 2002 (FY 2002). World Bank's Environment Department, Washington, DC.

Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: a conceptual approach. Ecol. Econ. 69, 1237–1244, http://dx.doi.org/10.1016/j.ecolecon.2009.11.004.

Pattayanka, S.K., Wunder, S., Ferraro, P.J., 2010. Show me the money: do payments supply environmental services in developing countries? Rev. Environ. Econ. Policy 4, 254–274.

Perevochtchikova, M., Vázquez Beltrán, A., 2012. The federal program of payment for hydrological environmental services as an alternative instrument for integrated water resources management in Mexico City. Open Geogr. J. 5, 35–46.

Persha, L., Andersson, K., 2014. Elite capture risk and mitigation in decentralized forest governance regimes. Global Environ. Chang. 24, 265–276.

Pirard, R., 2012. Market-based instruments for biodiversity and ecosystem services: a lexicon. Environ. Sci. Policy 19 (20), 59–68.

Racevskis, L.A., Lupi, F., 2006. Comparing urban and rural perceptions of and familiarity with the management of forest ecosystems. Soc. Nat. Resour. 19, 479–495, http://dx.doi.org/10.1080/08941920600663862.

Rico García-Amado, L., Ruíz-Pérez, M., Reyes-Escutia, F., Barrasca-García, S., Contreras-Mejía, E., 2011. Efficiency of payments for environmental services: equity and additionality in a case study from a Biosphera Reserve in Chiapas, Mexico. Ecol. Econ. 70, 2361–2368, http://dx.doi.org/10.1016/j.ecolecon.2011.07.016.

Rocheleau, D., Edmunds, D., 1997. Women, men and trees: gender, power and property in forest and agrarian landscapes. World Dev. 25 (8), 1351–1371.

Santos, C., Guarneros, L., 2006. La expansión metropolitana en las áreas naturales protegidas y el suelo de conservación. Un análisis a partir de imágenes de satélite. en Aguilar, A.G. (coordinador), Las grandes aglomeraciones metropolitanas y su periferia regional. Experiencias en Latinoamérica y España. Editorial Miguel Ángel Porrúa. SEDESOL, CONAPO, INEGI.

Schteingart, M., Salazar, C.E., 2005. Expansión urbana, sociedad y ambiente. El caso de la Ciudad de México, 1st ed. México Distrito Federal, El Colegio de México.

SEDATU (Secretaria de Desarrollo Agrario Territorial y Urbano), 2012. Boletin No. 66 Dirección General de Comunicación Social mayo 13. México D.F.

SMADF (Secretaria del Medio Ambiente del Distrito Federal). 2011. http://www.sma.df.gob.mx.2011.07.11

SEMARNAT (Secretaria de Medio Ambiente y Recursos Naturales), 2010. Servicios ambientales y cambio climático. Secretaria de Medio Ambiente y Recursos Naturales, México DF.

SEMARNAT, GDF, CORENA, DEOE, 2000. Programa General de Ordenamiento Ecológico del Distrito Federal 2000–2003. México DF.

Vidal, O., López-García, J., Rendón-Salinas, E., 2013. Trends in deforestation and forest degradation after a decade of monitoring in the monarch butterfly biosphere reserve in Mexico. Conserv. Biol., http://dx.doi.org/10.1111/cobi.12138.

Wunder, S., 2005. Payments for environmental services: Some nuts and bolts, CIFOR Occasional Paper, #42, 24.

Wunder, S., 2008. Necessary Conditions for Ecosystem Service Payments. Conference paper for economics and conservation in the tropics: A strategic dialogue January 31–921 February 1, 2008. Center for International Forestry Research.

Wunder, S., Albán, M., 2008. Decentralized payments for environmental services: the case of Pimampiro and PROFAFOR in Ecuador. Ecol. Econ. 65, 685–698, http://dx.doi.org/10.1016/j.ecolecon.2007.11.004.

Wunder, S., Engel, S., Pagiola, S., 2008. Taking stock: a comparative analysis of payments for environmental services in developed and developing countries. Ecol. Econ. 6, 834–852, http://dx.doi.org/10.1016/j.ecolecon.2008.03.010.

Wunder, S., 2013. When payments for environmental services will work for conservation. Conserv. Lett. 6 (4), 230–237, http://dx.doi.org/10.1111/conl.12034.