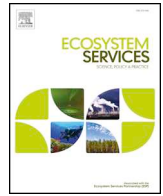




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The relevance of stakeholders' perceptions of ecosystem services in a rural-urban watershed in Mexico City



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ABSTRACT

Despite the term ecosystem services (ES) being important for the study of the relationship between ecosystems and society, it is still not clear how to incorporate the socio-cultural dimension. Therefore, it is important to analyze the environmental perceptions of stakeholders and their relationships with ES. This paper aims to identify the ES perceived by groups of stakeholders in a rural-urban area immersed in a complex socio-environmental dynamic and how those perceptions influence their decision making. Hydrological services are found to be the only ES perceived by all groups of stakeholders; nevertheless, the meaning associated with this and the other ES differs among stakeholder groups. There is a relationship between the perceived ES, the current activities or uses the stakeholders associate with the ES and the policies that aim to regulate the activities carried out within the study area. The implementation of policies aimed at regulating these activities and uses could modify the perception of the stakeholder groups. We consider a paradigm shift in the way activities and policies are being carried out to be necessary due to the effect they could have regarding the use of certain services, which could eventually compromise the generation of others.

1. Introduction

The term “ecosystem services” (ES) has been used since 1980 to relate ecosystems to human welfare. ES are defined as including goods and/or services that human populations obtain from ecosystems, including ecosystem processes (Boyd and Banzahaf, 2007; Costanza et al., 1997; Daly, 1997; de Groot et al., 2002; Kremen, 2005; MEA, 2003). In recent years, the concept has been widely used to foster integration between ecology and society (Carpenter et al., 2009; Reyers et al., 2010), and it has allowed the development of frameworks for the analysis of these relationships (Díaz et al., 2011; Felipe-Lucia et al., 2015). Furthermore, this term has been widely used in the development of conceptual frameworks while assessing the state of various ecosystems and to support policy formulation and implementation, such as the Millennium Ecosystem Assessment, the Global Land Project and, more recently, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Chaudhary et al., 2015; Díaz et al., 2015). However, although the use of the term ES has been an important watershed in the study of the relationship between ecosystems and society, it is still not clear how local participation should be implemented (Reed,

2008). Thus far, most studies have focused only on the biophysical component of the capacity of ecosystems to deliver services or on the economic value of ES (Hackbart et al., 2017; Karabulut et al., 2016; Villegas-Palacio et al., 2016), neglecting the social-cultural dimension (Chan et al., 2012a; Endter-Wada et al., 1998; Hull et al., 2001).

A range of typologies have been developed within the social-cultural dimension to understand the basis for stakeholders' participation. However, the range of interpretation is wide, and the importance of stressing empowerment, equity, trust and learning in stakeholder participation has therefore been emphasized. Thus, it is essential that stakeholder participation be considered as soon as possible and throughout the process, to allow the different stakeholder points of view to be taken into account at the time of the identification of problems and solutions (Felipe-Lucia et al., 2015; Hauck et al., 2013; Reed, 2008).

Environmental perception research is a first approach towards acknowledging the motivations, preferences and cultural values of people with regard to their ecosystems (Bird, 1987; Evernden, 1992; Proctor, 1998). Understanding different environmental perceptions is important because one ecosystem may be valued differently by different

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stakeholders in relation to its capacity to provide services that fulfill their own interests. In addition, if different stakeholders lack an awareness of the diverse existing perceptions, then conflict may arise (Chan et al., 2012a). Therefore, it is important to analyze the environmental perceptions of different stakeholders and their relationships with ES (Caceres et al., 2015; Chan et al., 2012b, 2012a; Martín-López et al., 2012; Menzel and Teng, 2010). Hence, research on environmental perceptions should consider the roles of the different stakeholders involved in relation to the ecosystem as well as the power relations between them. According to Felipe-Lucia et al. (2015), the power relationships are modulated by formal power asymmetries, informal power asymmetries and an imbalance of hidden power.

The methods used by researchers to understand environmental perceptions have been both quantitative (Bertram and Rehdanz, 2015; Ciftcioglu, 2017; Mensah et al., 2017; Muhamad et al., 2014; Pastorella et al., 2016; Slimak and Dietz, 2006) and qualitative (Caceres et al., 2015; Lamarque et al., 2011; López-Medellín et al., 2011; Proctor, 1998; Riechers et al., 2016; Souza et al., 2017). The qualitative approaches are based on the constructivist paradigm, which allows the analysis of realities from the stakeholders' point of view. The constructivist (also referred to as interpretivist) paradigm is based on the idea that the environment cannot be known and shared independent of its social context. The diversity of definitions of environment reflect the diversity of cultures, values, beliefs, and interactions with spaces and resources. Therefore, the environmental perceptions developed from a constructivist approach are largely explained by the way in which collective discourse is constructed. The researcher and her or his participants jointly create findings from their interactive dialog and interpretation (Bird, 1987; Evernden, 1992; Greider and Garkovich, 1994; Ponterotto, 2005; Proctor, 1998; Strauss, 1987).

Although an increasing number of studies have analyzed environmental perceptions under the conceptual framework of ES (e.g., Riechers et al., 2016; Souza et al., 2017; Tekken et al., 2017), a better understanding of the environmental perceptions of different stakeholders and how these perceptions influence decision making is needed. In particular, the role of local stakeholders should be taken into account in decision making, since regardless of the government's role, it is the local stakeholders that administers natural resources on a day-to-day basis and makes the most of management decisions, especially in developing countries (Getz et al., 1999). The aim of this paper is to identify which ES are perceived by different groups of stakeholders in a rural-urban area immersed in a complex socio-environmental dynamic and how those perceptions influence their decision making.

2. Methods

2.1. Study area

Mexico City is a megacity with complex socio-environmental problems (Ezcurra et al., 2006). Together with its metropolitan area, it is considered one of the largest cities in the world with approximately 21 million inhabitants (United Nations, 2014). Despite its large population, the city contains 884.42 km² of Conservation Area (Suelo de Conservación del Distrito Federal), which is equivalent to 59% of Mexico City (PAOTDF, 2005). The study area is located in the southwest part of the city (Fig. 1). For the purposes of this study, the area was divided into two zones: the Magdalena River Watershed (MRW) and the urban area of the Magdalena River. The MRW is located within the Conservation Area, bordering the rural-urban area of Mexico City because the Magdalena River flows into the urban area of the city. The MRW lies at 19° 13' 48"–19° 18' 00" N and 99° 14' 24"–19° 20' 24" W. It has a surface area of 30 km² and is considered the most important continuous mass of vegetation and one of the more diverse temperate ecosystems of central Mexico. More than 66% of the vegetation in the area is well preserved, and 24% of the plant species occurring within the whole Mexico basin are found there (Ávila-Akerberg et al., 2008;

Facultad de Ciencias-UNAM, 2008). The MRW contributes up to 2% of the water consumed in the city (Jujnovsky et al., 2010). Additionally, the MRW generates other ES of great relevance to Mexico City's inhabitants, such as carbon storage and cultural heritage, which are among the most-studied ES (Almeida-Leñero et al., 2007; Jujnovsky et al., 2016).

The Magdalena River is the main surface water body in Mexico City. The river has its headwaters at 3650 masl and runs for 12 km through the MRW and 10 km through the urban area of the city until it is piped. The river has good water quality in the upper portion, which deteriorates as water flows down to the urban area (Jujnovsky et al., 2010). Because it is difficult to follow the natural boundaries of the watershed in urban area, for the purposes of this study, the urban area of the Magdalena River was defined from where the urban settlements join the MRW to where it is piped, within a radius of 500 m on each side of the channel.

Despite the importance of the study area, the generation of its ES is threatened by the complex socio-environmental dynamic that is influenced by the historical and cultural context of its surrounding territory. The development of production activities has been very restricted for at least the last 40 years. With regard to forest management, a ban on logging has been imposed on all forest areas in Mexico City since the 1940s. At the same time, forest management authority over the MRW was granted to private companies until the 1980s (Vitz, 2012). Simultaneously, the agricultural activity in the area decreased, as agricultural workers found employment in other activities related to the tertiary sector in various parts of the city. Additionally, due to the expansion and development of new communication routes, there was increasing demand for housing in the study area; therefore, areas that were allocated for agricultural activities until the 1970s became occupied by housing settlements. Currently, the small areas of land used for agricultural purposes in the region are for self-consumption purposes (Cuadros, 2001; Ramos, 2008; Zamora, 2013).

The only production activities currently developed in the MRW are those related to recreation due to its relevance for Mexico City's inhabitants (Facultad de Ciencias-UNAM, 2008). Therefore, vendors have been present in the area for approximately 50 years, providing visitors with food and recreational services. These vendors are currently formally organized into an association (Acosta, 2001; Ramos, 2008). Other activities are linked to these activities, such as trout farming and the collection of firewood and mushrooms. These goods become supplies for the food services offered in the area and, to a lesser extent, for self-consumption (Ramos, 2008). Regrettably, recreational activities cause sewage discharges into the river, which have deteriorated the quality of the river's water (Jujnovsky et al., 2010). Additionally, the presence of bicycles and motorcycles lead to soil erosion, and solid waste is present in the main recreation areas (Almeida-Leñero et al., 2007).

In terms of land ownership, practically all the MRW is in the hands of the La Magdalena Atlitic agrarian community (landowners). However, due to the restrictions and the reduction in production activities in the area, most of the landowners are engaged in production activities outside the MRW (Aguilar, 2008; Ramos, 2008). The landowners that do obtain an income from the MRW are those vendors or others who receive an economic incentive through public conservation policies and programming.

As mentioned previously, the proximity of the MRW to the urban part of the city has promoted a high demand for housing in the area (Aguilar, 2008; PAOTDF, 2005). Currently, the population that is settled near the MRW is very heterogeneous and includes landowners, vendors, and residents who settled in the area due to the growth of the city. In general, the households located in this territory are the most precariously situated and the most densely populated, and its occupants receive a lower monthly income than the rest of the urban area of the Magdalena River (Ramos, 2008).

In the urban area of the Magdalena River, the dynamic of the watershed has been completely modified by the presence of settlements,

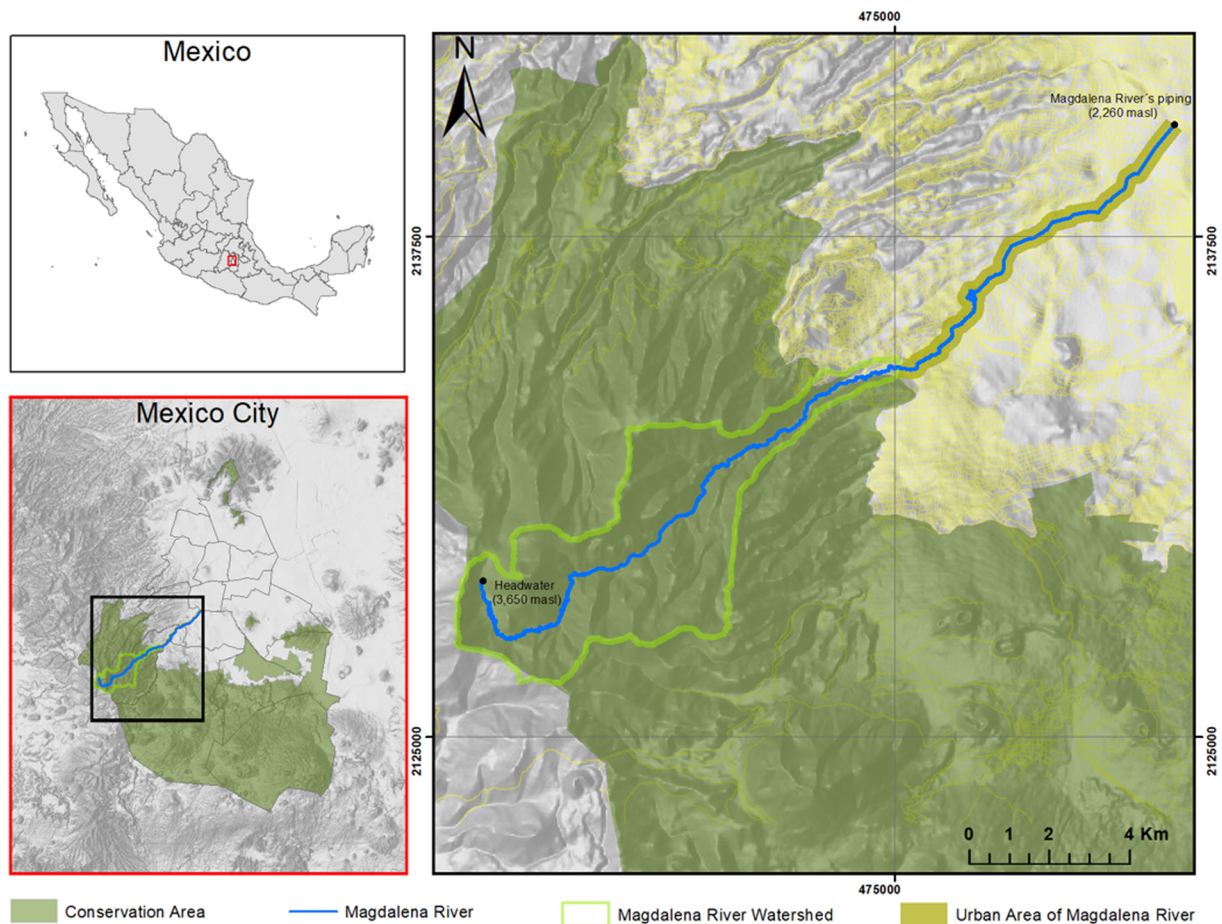


Fig. 1. Study area.

and the water quality of the Magdalena River is declining (Jujnovsky et al., 2010). The population that lives close to the river also presents very heterogeneous characteristics, but generally speaking, the population that resides in the lower part of the urban area of Magdalena River has a higher income than the population from the upper part of the urban area of the Magdalena River (Instituto de Geografía-UNAM, 2008).

In recent years, various government authorities have shown an interest in or had an influence on the development of infrastructure and the conservation programs at either the river or forest level. Some of the government authorities implementing programs and/or providing support for the implementation of works in the forest are the Forest Management Federal Agency (CONAFOR), the Mexico City Natural Resources Agency (DGCORENA), and the Municipal Mayor (Alcaldía La Magdalena Contreras). The Mexico City Environment Agency (SEDEMA) is responsible for all environmental issues in the city and promoted the development of the Environmental Rescue of the Magdalena and Eslava Rivers Program between 2007 and 2012. This program has been considered one of the most representative “rescue programs” of urban rivers in the city (SMA, 2012; Jujnovsky et al., 2017). Mexico City’s Water Agency (SACM) conducts activities related to drinking water and sanitation. The Mexico City Rural Development Agency (SEDEREC) provides support for the development of agricultural and aquaculture activities. Unfortunately, these government authorities do not have a common vision, and in some cases, their activities overlap. (Jujnovsky et al., 2017).

2.2. Analysis of perceptions of ES and their role in decision making

The perceptions of ES were obtained from stakeholder groups with

common characteristics. We decided to record perceptions collectively because our study focuses on analyzing whether the collective discourse on ES generated in rural-urban ecosystems may be influencing the decisions made in these locations. First, the potential group of stakeholders were identified according to the degree (most, moderately or least) 1) to which they could indirectly impact ES production or 2) could directly impact ES production and simultaneously benefit from or be negatively affected by the presence or absence of these services (Felipe-Lucia et al., 2015; Hauck et al., 2014). Our presence in the community for at least five years prior to the study allowed us to identify different groups of stakeholders in the study area. Additionally, the research tools used to gather data on the perceptions of ES, described below, allowed us to identify groups of stakeholders who had not been previously identified. Second, we proceeded to allocate the different groups of stakeholders in a “rainbow diagram” (Fig. 2; the specific criteria used to place the different groups of stakeholders are shown within the figure), which allowed us to select the groups of stakeholders that would participate in our study (highlighted in gray within Fig. 2).

Participant observations and in-depth interviews were the research tools used in this research to gather data on the perceptions of ES from the different groups of stakeholders. Participant observations were carried out during four participatory planning workshops and four discussion groups. All of these activities were part of the Program of Environmental Rescue of the Magdalena and Eslava Rivers (February–March 2008). The main objective of this program was to make a socio-environmental diagnosis of the MRW and the urban area of the Magdalena River; however, our team requested that, at the beginning of the participatory planning workshops and the discussion groups, the moderators direct the discussion to reach the objectives of our research.

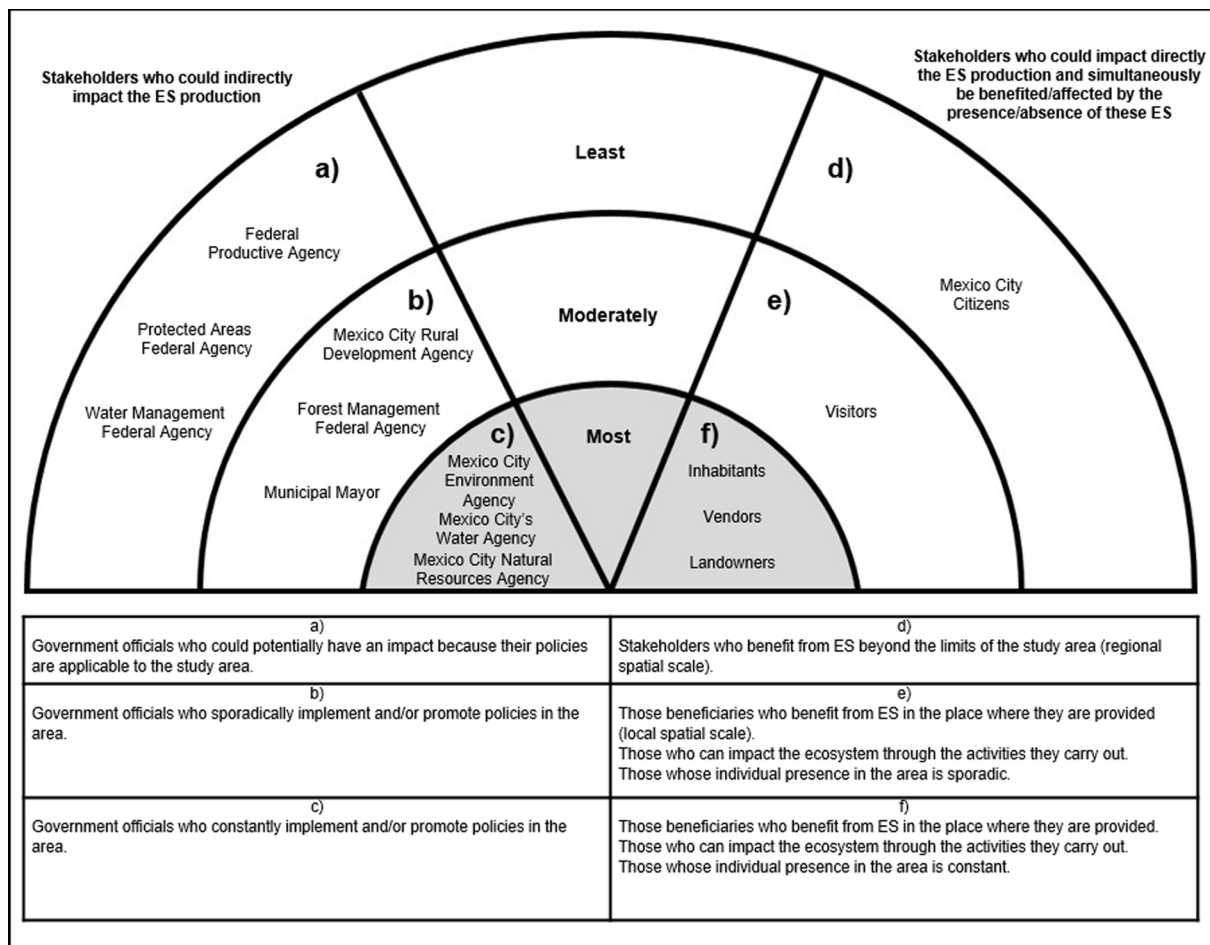


Fig. 2. Classification of stakeholders identified in the study area (Own elaboration based on Chevalier and Buckles, 2008 in Reed et al., 2009). The groups of stakeholders that participated in our study are highlighted in gray.

The participants were selected jointly between the researchers and the group in charge of coordinating this program. However, it is important to mention that the participants in the participatory planning workshops and in the discussion groups were incorporated throughout the activity and that some of them left before it ended. In addition, although a registration form was requested, some of the attendees did not complete it. Therefore, only an approximate number of attendees is available.

Approximately 50 landowners and 50 vendors attended the first two participatory planning workshops. These workshops were conducted in two different venues located close the Magdalena River. The first venue is where landowners hold regular meetings within the MRW, and the second venue is located in the urban area of the Magdalena River (the upper part), where the population is characterized by the lowest income in the study area. These workshops were composed mainly of men between the ages of 40 and 70. The composition of the workshops mirrors the age group of the landowners and vendors. The two remaining participatory planning workshops were directed at the inhabitants and had approximately 15 attendees each. These workshops were conducted in the lower part of the urban area of the Magdalena River, where the population is characterized by the highest income. The first workshop was composed exclusively of women between 35 and 60 years of age. In the second workshop, the gender distribution was balanced, and the age of the participants was between 35 and 70 years. The discussion groups were composed of representatives of authorities of the Environmental Agency of Mexico City and Mexico City's Water Agency (approximately 10 people each). The discussions were conducted in the facilities of the National Autonomous University of

Mexico, which is located outside the study area.

To gather stakeholder groups' perceptions regarding ES, the moderators used four guiding questions to lead the participatory planning workshops and the discussion groups: Why is this forest/mountain important to you? What could its importance be for other people? What are the benefits that this forest/mountain could provide you or other people? What needs to occur for us to be able to receive these benefits? (The discussion was focused on the relationship between the characteristics of the ecosystem for the generation of ES, beyond its socio-political implications.) Is there a policy that promotes or limits the use of these benefits? To avoid this research being biased and to complement the information gathered through the groups, we conducted 17 in-depth interviews.

The in-depth interviews were conducted among people whose perceptions might not have been reflected in the discussion groups. The age range of the interviewees was between 30 and 65 years. Thirteen in-depth interviews were conducted with landowners, vendors and inhabitants between July 2008 and January 2009 (Table 1). Finally, four in-depth interviews were conducted with government officials

Table 1 Interviewees' characteristics.

	Participated in workshops	Did not participate in workshops or discussion groups
Landowners	1 man	3 women, 1 man
Vendors	1 man	2 women, 1 man
Inhabitants		3 women, 1 man

responsible for environmental projects in the MRW and/or the urban area of the Magdalena River in January 2010: one with a government official in charge of the Mexico City Environment Agency, one with a government official from the Mexico City Natural Resources Agency, and the other two with government officials from Mexico City's Water Agency. The guiding questions used in the in-depth interviews with landowners, vendors, inhabitants and government officials were the same as those used during the participatory planning workshops and the discussion groups.

Although the number of participants in the participatory planning workshops and discussion groups or interviewees did not statistically represent the larger local stakeholder groups, we believed that their input could still provide an illustrative case study that would be helpful for understanding which benefits generated by the ecosystem may be perceived by different stakeholders in a rural-urban area immersed in a complex socio-environmental dynamic.

All in-depth interviews, participatory planning workshops and discussion groups were conducted in Spanish, which is the official language in Mexico, and recorded on a digital recorder in WAV format and transcribed in TXT format. All the transcriptions were read line by line into Atlas.ti software version 4.2. To enrich the results of the analysis, two people read all the text and searched and coded the phrases. The phrases were coded based on the ES classification of the MEA (2005). Table 2 shows the criteria used for the selection of these phrases. The fragments of text presented in this article are direct translations from Spanish to English with some minor adaptations due to language.

Finally, to identify how various perceptions influence the decision making of the groups of stakeholders, we performed a cross-comparison between these perceptions and the activities and public policies that are being implemented in the study area. Here, “decision making” refers to the activities and uses that are in practice that can influence land-use and the public policies that are being implemented in the study area. We use the term “public policies” to refer to government programs and legislation. Regarding legislation, only those laws and/or regulations that are implemented in practice are reported [reinterpreted “rules-in-use” (a.k.a., “working rules”)] for common pool resources (Ostrom,

1990). The activities and public policies that are being implemented in the study area were identified through participatory planning workshops, discussion groups and in-depth interviews. In addition, a bibliographic review of press and digital material for the period to be evaluated was conducted. The information obtained is presented in Fig. 4, where the ES that are perceived by the different groups of stakeholders who participated in our study are presented, along with the associated activities and/or related uses and the policies that are implemented.

3. Results

3.1. Which ES are perceived by different stakeholders?

The ES perceived by different groups of stakeholders are freshwater, water regulation, air purification, recreation, cultural heritage, food, fuel wood and non-timber products. Some ES are perceived by all the groups of stakeholders, while others are perceived by only some stakeholders (Fig. 3). For the purpose of this study, freshwater and water regulation are grouped as hydrological services. In this group, all the ES related to water are considered because, as noted by Pinto et al. (2013) and Hackbart et al. (2017), these ES exhibit a transversal perspective, and unlike other natural benefits, hydrological services are included in all the ES categories described by the MEA (2005). Aesthetic services are also ES with a transversal perspective and are related to other ES, because of which these services were not mentioned individually by the stakeholders. Therefore, aesthetic services are considered to be an attribute of other ES for this analysis.

Hydrological services are the only ES perceived by all the groups of stakeholders. However, the meaning is different among different stakeholders. Every stakeholder related hydrological ES with the presence of the river from the point of view of the water supply, aesthetics and cultural heritage.

e.g., “...Our community is called Atlitic because of the river; it means ‘in the water’ or ‘stone in the water’.”
(Landowner)

Table 2
Criteria used for the coding of sentences related to ES.

Ecosystem services	Criteria used to the selection of the phrases	
Provisioning	Freshwater.	Water available for human consumption (e.g., for drinking, irrigation, and cleaning purposes) obtained from the main and secondary river channels and from natural springs.
	Timber.	Includes the commercialization or local consumption of the materials derived from primary forest cover (e.g., wood) obtained from the demolition of trees.
	Non-timber products.	Products and materials, other than timber, derived from primary forest cover, which do not require harvesting trees (e.g., resins, soil, ornamental plants, medicinal plants or other useful plants).
	Food.	Food products derived from plants, animals and wild and cultivated mushrooms.
	Fuel wood.	Wood, dung, and other biological materials serve as energy sources.
Regulating	Genetics resources.	Biological elements of the ecosystem used to obtain products for medical and biotechnological development.
	Air purification.	Ecosystems (e.g., forest cover, litter, and soil) contribute to the extraction of chemicals from the atmosphere, influencing many aspects of air quality.
	Water regulation.	Ecosystems filter water and drain it gradually, allowing sufficient quantity and quality of water to be obtained.
	Control of floods and erosion.	The vegetative cover present in ecosystems reduces the erosion caused by the mechanical action of water and wind, preventing landslides and floods.
	Pollination.	The role of some animals of transferring pollen grains from one plant to another, thereby enabling fertilization to occur.
Cultural	Disease Control.	Ecosystem changes affect the distribution and abundance of organisms, which controls the population of unwanted organisms.
	Recreation.	The psychological, physical and/or economic benefits that are obtained from the development of sports, ecotourism, and artistic and spiritual activities.
	Cultural heritage.	The cultural identity associated with the ecosystem (land), the attachment to the land, and the permanence of several generations of the same family, which is seen through culinary or food culture and traditional ways of life (e.g., agriculture and forestry).
	Aesthetic.	The benefit provided by the enjoyment of the landscape and biodiversity.
Supporting	Educational.	The importance of the ecosystem for the development of formal (e.g., scientific research) and informal (e.g., environmental education activities) education.
	Nutrient cycling.	The interaction between processes that ensures elements are in constant movement (nitrogen, phosphorus, carbon, etc.), which allows for the proper functioning of ecosystems.
	Soil formation.	Process by which factors such as climate, relief, living organisms, parent rock and time interact with each other to form soil.
	Primary production.	Exchange of matter and energy by vegetation, which allows for respiration and photosynthesis to occur.

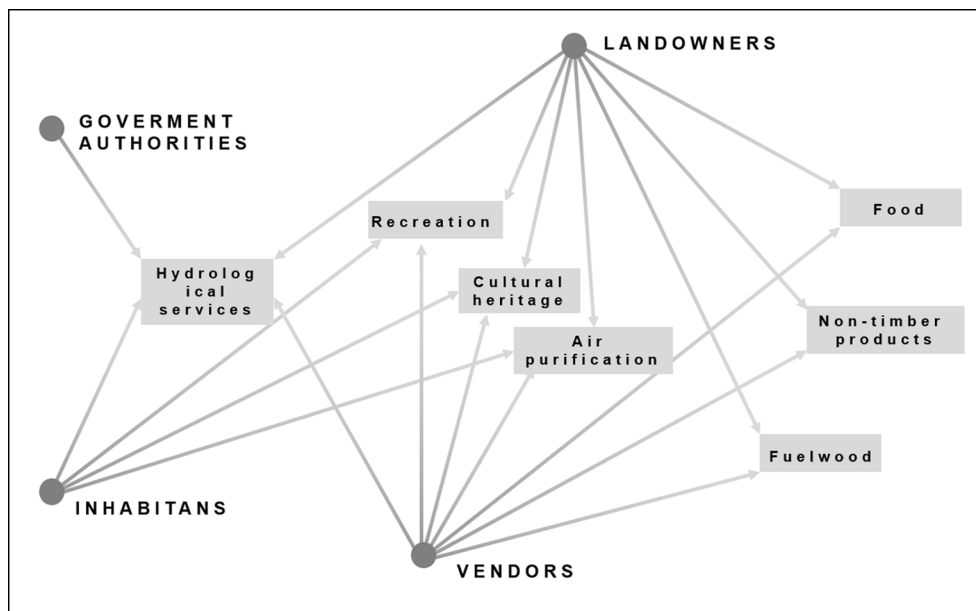


Fig. 3. Perceptions of ES by different groups of stakeholders in the study area.

e.g., “...Here, in the city, it’s the only river we have left...”
(*Inhabitant*)

However, landowners, vendors, and government officials from the Mexico City Environment Agency and the Mexico City Natural Resources Agency perceived the relation between the vegetation cover and water supply and how these two relate with the regulation of water quantity and quality. In contrast, Mexico City’s Water Agency as well as inhabitants do not perceive this relationship.

e.g., “...I’m interested in indicators that will be best suited to tell us about the general health of the ecosystem; I’m not talking about the river, I’m not talking about the forest, I’m referring to indicators that tell us about the state of the watershed...”
(*Government Official from the Mexico City Environmental Agency*).

e.g., “...Without trees, without forest, without anything, there would be no water, and water is the most important”
(*Landowner*).

Air purification, recreation and cultural heritage are also ES that are perceived by landowners, vendors and inhabitants. In the case of air purification, the meaning attributed by different groups of stakeholders is almost the same, and it is always associated with the forest cover.

“...this is a forest that has clear air here, and there’s no pollution...”
(*Vendor*).

The meanings of recreation differ among the groups of stakeholders. For the landowners and vendors, the recreation is associated with the aesthetic of the MRW and the possibility of carrying out economic activities. In fact, these groups of stakeholders directly mentioned employment as a benefit provided by the MRW. On the other hand, for inhabitants, recreation is solely associated with the aesthetic of the MRW.

e.g., “...We don’t get any economic benefit from the wood other than from selling things...” [referring to the sale of food]
(*Vendor*).

e.g., “This forest is a green area to rest and to walk... there are many people who engage in outdoor sports, which in other parts of the city is more complicated to engage in”
(*Inhabitant*).

The meaning of cultural heritage is also different among the groups

of stakeholders. Landowners and vendors link cultural heritage with the indigenous presence within the study area since pre-Hispanic times, which is a characteristic that gives them an identity linked to the territory and past. For the inhabitants, this ES relates to the possibility that future generations may enjoy the area.

e.g., “There are still many native people in the region... our ancestors arrived here at the time of the Mexicas”
(*Landowner*).

e.g., “...In the old days, we used to walk in a forest full of beautiful trees; it was gorgeous. Now, many of those trees are gone; who knows what we will pass on to future generations”
(*Inhabitant*).

Food, fuel wood and non-timber products are ES that were uniquely mentioned by landowners and vendors. These services are mainly associated with food stalls and domestic use.

e.g., “...They sell trout, and people come and cook them here especially on Saturdays and Sundays...”
(*Landowner*).

“...We people who live in the forest use the wood... we go to gather it...”
(*Vendor*).

In this sense, landowners and vendors made explicit reference to the potential usage of some of these ES. However, they mentioned only a few non-timber products and foods.

e.g., “...In our forest, there’s lots of ‘perlilla’ [*Symphoricarpos microphyllus*, little pearl or “escobilla” (broom)]; perlilla sticks are useful for sweeping. There’s a lovely perlilla, so good, we could take truckloads of perlilla”
(*Landowner*).

3.2. How are perceptions related to decision making?

Our results show that there is a relationship between the ES that are perceived, the current activities or uses the different stakeholders attribute to the ES and the policies that aim to regulate the activities carried out within the study area (Fig. 4). The perceived ES are related to the current activities of the different stakeholders, with the exception of cultural heritage, which (as described in the previous section) could

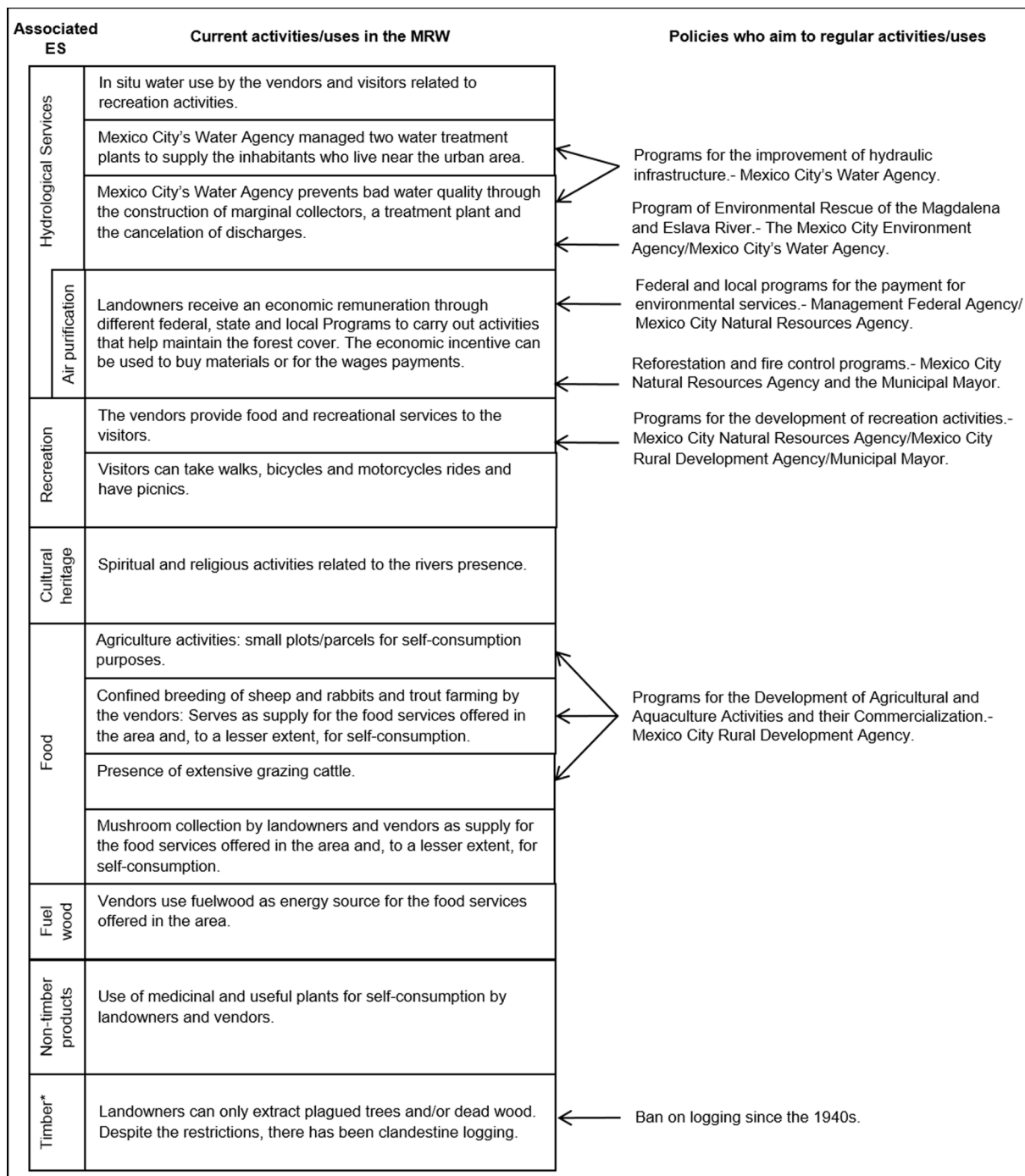


Fig. 4. Relationship between perceived ES, current activities or uses that are carried out and policies aimed at regulating the activities in the study area. *Timber was not perceived by any group of stakeholders. However, it is taken into account because current policies could be the reason that this ES is not perceived.

be linked to the indigenous presence within the study area since pre-Hispanic times according to the landowners and vendors. Whereas, the inhabitants' tend to link this ES to the change the landscape has experienced over time.

The implementation of policies aimed at regulating these activities and uses could be modifying the perception of the different stakeholder groups. For example, the implementation of water policies, particularly the Program of Environmental Rescue of the Magdalena and Eslava River, could be influencing the perception of those who can impact ecosystems *the most* through the activities they carry out (i.e., landowners, vendors and inhabitants), due to the impact this program has in attracting the attention of the media, mainly including newspapers and

electronic media (e.g., SMA, 2010). Payment for environmental services, reforestation and fire control programs could also alter landowners' perception regarding hydrological ES and air purification, due to the economic reward they receive by being part of these programs. Moreover, specific programs regarding recreation, agricultural, livestock and aquaculture activities could also influence the perception of landowners and vendors concerning recreation and food ES, since these policies are addressed towards these groups of stakeholders and represent a possibility for obtaining an economic income. On the other hand, the prohibitions on the use of timber that have been imposed from the mid-twentieth century to date (DOF, 1947) could explain why this service is not perceived.

Finally, we consider that the perceptions of government officials could have implications for the way in which public policies are designed and implemented, mainly for the hydrological ES and for those policies that promote the maintenance of forest cover. In the case of hydrological ES, the perceptions of the government officials could be reflected in the way in which hydraulic works are implemented in the river. According to our results, Mexico City's Water Agency, which oversees the implementation of hydraulic works, perceives this ES exclusively in terms of a provision, ignoring its importance as a regulatory and support ES. This understanding probably influenced in the type of construction implemented during the Program of Environmental Rescue of the Magdalena and Eslava, which focused only on the provision of the service, even though the program was developed under an integral water management approach (SMA, 2010). Regarding policies that promote the maintenance of forest cover, the perceptions of government officials could have implications in the way in which the policies are designed and implemented. For example, these policies depart from the premise that it is necessary to maintain the ecosystem and center solely on increasing forest cover, even with species that do not correspond to the altitudinal tiers.

4. Discussion

The perception of the different ES by the stakeholders in the MRW and the urban area of the Magdalena River is explained by the way in which a collective discourse is constructed, specifically regarding the diversity of values, beliefs and the way people interact with the environment (Bird, 1987; Evernden, 1992; Proctor, 1998). In turn, the differences in the way ecosystems and ES are perceived by different groups of stakeholders may have implications for the way in which decisions are made (Hauck et al., 2013; Menzel and Teng, 2010). According to our analysis, the uses and activities attributed to the ES and the way in which these activities are carried out emanate from the relation between the different associated perceptions and the interaction with the environment and in turn are related to the public policies implemented in the study area. This finding is consistent with the findings of Felipe-Lucia et al. (2015), who reported that there is a relationship between the mentioned environmental services and the roles of the different groups of stakeholders related to the ecosystem. Additionally, it must be considered that the perception of each of the services may be due to different causes, which are described below.

The perception of hydrological ES among stakeholders has been widely discussed in the literature (Hull et al., 2001; Postel, 2003; Racevskis and Lupi, 2006; Sánchez-Matías, 2010; Souza et al., 2017). In fact, some authors, such as Falkenmark and Folke (2003) and Brauman et al. (2007), have described water as the ES that is most relevant to society because of its role in human wellbeing. Nevertheless, as shown by our results, it is important to identify the different meanings that different groups of stakeholders attribute to the hydrological ES and to identify how these perceptions relate to the activities and uses that are implemented by the stakeholders as well as the policies they implement. It appears that the authority in charge of water management in the study area (Mexico City's Water Agency) perceives the hydrological ES only in terms of provision, which could explain why the type of construction implemented altered the dynamics of the riverside at certain points to secure the supply of water (Ramos, 2013), even though the national water policy recognized the need to manage water based on integrated water resources management (Cotler and Caire, 2009). In addition, this type of construction could be one of the causes of the conflicts between the authority and other stakeholders reported by Zamora (2013) when the hydraulic works were implemented. This contradiction is consistent with Pahl-Wostl et al. (2011), who indicated that despite the fact that there has been a theoretical paradigm shift in the way water is managed, in practice, there is a dominant view of the extraction of water that does not recognize the functions and processes of the ecosystem that are necessary to maintain a high quality and

quantity of water.

Concerning air purification, as shown by our results, the perception of those who receive economic retribution from different programs (payments for ES, reforestation and firefighting) could be modified by the programs themselves, in accord with previous studies (e.g. Almeida-Leñero et al., 2017). Nevertheless, as Fortner et al. (2000) pointed out, the perception of air purification could be a consequence of a collective construction of climate change and atmospheric pollution, which is one of the most relevant environmental problems in the city. Moreover, regarding Mexico City, Lezama (2004) reports that the opinions of different stakeholders, such as academics and environmentalists, as well as the symbols shown in mass media have the strength of the collective perception of the poor air quality in Mexico City. This situation could explain why the inhabitants perceive this particular ES and why different reforestation programs have been implemented in the MRW, even though this ES has not been mentioned or stressed by government officials. On the contrary, these programs have focused on only increasing forest cover, which results in the introduction of tree species that may even be exotic or not adequate for the altitudinal range (Santibañez-Andrade et al., 2015). These types of practices could result in the loss of other ES and biodiversity (Carabias et al., 2007; Holt-Giménez, 2002; Hulme and Vilà, 2017).

Regarding recreational ES, the perceptions of this ES may be due to different causes. As well reported in the literature, this is a service that many stakeholders perceive (Hull et al., 2001; Racevskis and Lupi, 2006; Riechers et al., 2016; Sánchez-Matías, 2010; Solórzano-Murillo, 2008). In addition, the MRW has been an important site of recreation for the inhabitants of Mexico City since the early 20th century (Acosta, 2001; Mazari-Hiriart et al., 2014; SMA, 2010), which has been associated with the capacity to perform production activities by landowners and vendors and with aesthetic value in the case of inhabitants. However, as shown by our results, government officials tend to omit this ES. This omission could be related to the fact that government officials see recreation as a threat, which could cause recreation activities to be carried out in a disorderly manner, resulting in effects on other ES, for example, resulting in soil compaction (Almeida-Leñero et al., 2007).

Cultural heritage, like the majority of cultural ES, is one of the least reported ES in the literature because it has been less well studied than other ES (Chan et al., 2012b; Fortner et al., 2000; Riechers et al., 2016). However, the presence of indigenous people has been documented in the study area since pre-Hispanic times (Acosta, 2001), which is a characteristic that gives landowners and vendors an identity linked to the territory and past and could explain why these groups of stakeholders mentioned cultural heritage. For the inhabitants, the changes that the landscape has suffered in the 20th and 21st centuries (Almeida-Leñero et al., 2007) may explain why they perceived this ES. In this context, it is important to note the omission of cultural heritage by government officials. This omission may have occurred because such ES have been among the most difficult to translate into monetary terms and therefore have not been taken into account in the decision making process (Chan et al., 2012b). However, it should be noted that the ES framework has become a prominent basis for planning and management, and cultural services are some of the most compelling reasons for ecosystem conservation, so it is essential that they be incorporated into the policies (Chan et al., 2012b). Thus, we expect that our results contribute to identification of the factors that lead different stakeholders to perceive the relevance of cultural heritage.

It is likewise relevant to analyze the reasons why landowners and vendors mention fuelwood, food and non-timber products. This perception may occur because these kinds of ES are some of the more tangible ES and may be more highly valued than other ES types (Carpenter et al., 2009; Hauck et al., 2013; Vitousek et al., 1986). Even though landowners and vendors did perceive those ES in our study, they mentioned only a few non-timber products and food, which could be related to the fact that the population of the study area has faced significant changes in socioeconomic dynamics, given the abandonment

of primary production activities (Aguilar, 2008; Ramos, 2008). This situation contrasts with other agrarian communities that depend more on their natural resources, making these ES more evident (e.g., Caceres et al., 2015; Maass et al., 2005).

The omission of fuel wood, non-timber products and food by the inhabitants and government officials could be a response to the fact that the inhabitants are not direct or potential beneficiaries of these ES, and the government officials see their exploitation as a threat to the conservation of the ecosystem, which is based on the conceptualization of conservation detached from the development of production activities (Fischer et al., 2014; Wilshusen et al., 2002). However, the current situation is far from promoting the conservation of the area. On the contrary, it has prevented agricultural practices associated with the production of food and the extraction of non-timber products from being framed under a comprehensive approach that allows the conservation of ES (Almeida-Leñero et al., 2007). Therefore, obtaining a benefit from these ES could compromise other ES. In fact, for landowners and vendors, food represents a recovery of cultural identity and the possibility of obtaining economic remuneration; thus, some of them maintain small areas for agricultural purposes for self-consumption, and others carry out trout farming or collection of mushrooms. The latter activities supplies both the food services offered in the MRW and, to a lesser extent, self-consumption (Cuadros, 2001; Ramos, 2008; Zamora, 2013).

Finally, it is important to analyze those ES that the MRW provides (Almeida-Leñero et al., 2007; Facultad de Ciencias-UNAM, 2008) that were omitted by the groups of stakeholders who participated in our study. Although forest ecosystems are frequently valued in terms of timber (MEA, 2005; Rodríguez et al., 2006), none of the groups of stakeholders who participated in our study mentioned this ES. Our results suggest that this may be related to the fact that forest ecosystems in Mexico City are under a logging ban (CONAFOR, 2006; DOF, 1947), despite criticisms of this conservation model (Vitz, 2012; Wilshusen et al., 2002). On the other hand, excluding the regulation of the quantity and quality of hydrological ES and air purification, other missing regulatory and supporting ES were not mentioned by the groups of stakeholders who participated in our study. This lack of response is consistent with studies by other authors (e.g., MEA, 2003; Rodríguez et al., 2006) indicating that it is easier for people to perceive cultural and provisioning ES than to perceive regulatory and support ES. The fact that these ES are not always perceived could be the reason that activities like recreation, food production or recollection have negative consequences on the ecosystems, especially because the relationship between regulatory and support ES and the role they play in the provision of other ES are not considered.

5. Final considerations

The present study has offered a first approximation as to which ES are perceived by different groups of stakeholders in a rural–urban watershed in Mexico City, and how these perceptions may also be reflected in decision making. We consider it necessary to have a paradigm shift in the way in which conservation works are being implemented in this type of rural-urban ecosystem, where perceptions seem to be based mainly on the provision of hydrological ES. Under this scheme, the relationship between the supply of these ES and other hydrological services (like the regulation of the quality, quantity and temporality of water; erosion control; water infiltration; microclimate control and hydrological cycle in general) need to be incorporated in a holistic policy. The same is true for the rest of the ES to consider the use of some services without compromising the generation of others, as is currently the case with recreation and food.

On the other hand, our results show that the perceptions of local stakeholders regarding ES, especially those of the landowners and vendors, is much broader than those of government officials. Therefore, it is essential that there is a real paradigm shift regarding who should

have input in governance. There is evidence that projects involving local people from the earliest stages of decision making are much more successful. Ignoring their perspectives can trigger conflicts in areas that are already extremely complex, as is the case in the investigated rural-urban area immersed in a complex socio-environmental dynamic in Mexico City.

Our results cause us to reflect upon the accomplishments of the conceptual framework of ES in decision making, especially given that it still seems difficult for several stakeholders to relate regulatory and support services with other ES. Consequently, decisions are still being made independently of ecosystem processes. Therefore, there is a latent risk that such a conceptual framework does not transcend academia and pervade real and practical situations.

Finally, we feel that the perceptions of the different stakeholders should be considered in future policies and that strategies should be implemented that reflect the relationship between regulatory and support services and other ES.

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