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Ecosystem services approach in Latin America: From theoretical promises to real applications

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1. Introduction: Great expectations on Ecosystem Services approach

The Ecosystem Services concept has become a tool widely used to understand the links between the functioning of ecosystems and human well-being to inform policy makers and land-use managers (Fisher et al., 2009). The Ecosystem Services Approach (hereafter, ESA) underwent a remarkable theoretical and methodological development in the last two decades (Costanza et al., 2017). In Latin America, the scientific community adopted the framework very early and made its own significant contributions (Balvanera et al., 2012). Nonetheless, there is a common perception that the ESA has not been extensively incorporated in private and public decision making as it was initially expected (Ruckelshaus et al., 2015; Laterra et al., 2017; Olander et al., 2017; Saarikoski et al., 2017). There is still work to do in mainstreaming the concept, as one possible tool to help solve ongoing socio-environmental problems (Dick et al., 2017; Saarikoski et al., 2017).

The development of ESA was based on a series of premises that generated great expectations, compared to previous conservation approaches (e.g., biological conservation based on protected areas; community- based natural resources management). One of these premises is that the ESA would facilitate the interaction among sectors of society involved in the management, utilization and investigation of ES (de Chazal et al., 2008; Fagerholm et al., 2012). In this way, ESA would transcend the pure scientific curiosity, to influence on public and private decisions and reconcile conservation and development goals (de Groot et al., 2010; Maes et al., 2012; Hauck et al., 2013).

Recent reviews and case studies in Latin America and across the world showed that these expectations were not completely fulfilled (Schröter et al., 2014). Whereas ESA has promoted integration between different sectors of society (researchers, policy makers and other members of society), the dialog among them around the concept of ES is still limited and an ongoing challenge for nature governance (Cowling et al., 2008, Wright et al., 2017). Each sector has different internal dynamics given by their values, forms of knowledge and problems they have to deal with, making the interaction with the other sectors difficult (Dempsey and Robertson, 2012; Nahuelhual et al., 2018a). At worst, serious conflicts may arise, and further collaboration may be discouraged as it has been documented in the implementation of REDD + compensation programs in Mexico (Špirić et al., 2016).

On the other hand, interventions on socio-ecosystems (the actions oriented to ensure ES supply and benefit distribution) have been implemented through different approaches like economic incentives and regulations (e.g. Payments for Ecosystem Services, PES) or land-use planning with varying degrees of success. PES, for example, are one of the most broadly applied policy tools, especially in Latin America (Grima et al., 2016), but they have not always proved effective in terms of environmental or equity issues (Ezzine-de-Blas et al., 2016; Aguiar et al., 2017). Policy tools relying on planning or communal management, have been effective in some cases (Velázquez et al., 2004; Panizza

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and García Collazo, 2014), but sometimes power relations between stakeholders impede achieve desired outcomes (Berbés-Blázquez et al., 2016; Cáceres et al., 2016; Cabrol and Cáceres, 2017).

In this context, we see that there is still a long road to contribute to solving environmental problems by means of this approach. Tackling the mismatch among internal dynamics of different sectors may be one of the greatest challenges we have today to mainstream ES in decision-making (Bennett et al., 2015; Nahuelhual et al., 2018b). The need to facilitate collaboration between researchers, policy makers and other sectors of society is, obviously, prior to and independent from the ESA (Roux et al., 2006; Gurvich et al., 2009; Paruelo, 2009; Weichselgartner and Kasperson, 2010; Fernández, 2016; Keeler et al., 2017) but maybe it is more evident than ever before given the severity of the environmental problems and the poor progress towards most conservation and development targets (e.g. Aichi targets, Sustainable Development Goals). The issue of relationships between sectors deserves especial attention in the context of the application of ESA in Latin America and relevant questions arise. What are the characteristics of the different sectors and their interactions around environmental management in the Latin American context? Which pathways of ESA mainstreaming have been theorized? Which are the real pathways of ESA mainstreaming in Latin America and their outcomes? In this paper, we intend to answer these questions. We argue, as a working hypothesis, that one of the main reasons why the ESA has not been sufficiently mainstreamed in Latin America is the tangled relationships among sectors involved in ESA implementation (academia, public policy makers, society), that lead to different pathways of ESA mainstreaming in Latin America.

2. Methods

This article emerged as a result of a workshop held at the V International Congress of Ecosystem Services in the Neotropics (CISEN V). The proposal for the workshop entailed sharing experiences of mainstreaming the ESA into environmental decision-making in different contexts of Latin America and identifying common factors and processes explaining the success or failure of those initiatives. Researchers from different Latin American countries participated in the workshop presenting their experiences. The main conclusion of the participatory workshop was that the pathways and outcomes of intersectoral efforts aimed at mainstreaming the ESA into decision-making are highly dependent on the characteristics and relationships among sectors involved in the mainstreaming process. Taking this observation as a starting point, we undertook a series of interdisciplinary discussions, reviews of the literature and analysis of case studies with the purpose of synthesizing existing evidence on the roles played by the scientific, political and society sector in environmental governance in Latin America, and their influence on the pathways and outcomes of initiatives for ESA mainstreaming into decision-making.

In this paper, we present the results of our analyses characterizing the sectors according to seven criteria that reveal potential impediments or facilitators to the mainstreaming of ESA: i) engagement, ii) knowledge, iii) language, iv) time lag, v) time, vi) competence/agency, and vii) rewards (Section 3.1). We then discuss how the three sectors interact with each other and the role of knowledge brokers and boundary organizations in this dynamic (Section 3.2). In the following section, we describe two general pathways by which the ESA can be mainstreamed into environmental decision-making, which are: i) the information deficit pathway, which emphasizes the transference of information from the scientific to the policy sector, and ii) the power dynamics pathway, which emphasizes the negotiation of interests and building of consensus among sectors (Section 3.3). These pathways are exemplified by analyzing in depth four Latin-American experiences of ESA mainstreaming (case studies in Section 3.4). These case studies are: i) governmental economic incentives for the conservation of Southern Cone Grasslands (Argentina, Uruguay, Brasil, Paraguay), ii) ejidos of the Ayuquila river middle basin (Mexico), iii) water governance in the commune of Panguipulli (Chile), and iv) Río Grande basin management (Colombia). Finally, we integrate the review of characteristics and relationships among sectors with the analysis of ESA mainstreaming pathways and case studies in order to discuss the emerging factors and processes influencing the outcomes of Latin-American initiatives to mainstream the ESA into environmental decision-making (Section 4).

3. Results

3.1. Characteristics of sectors influencing ESA mainstreaming

For this characterization, we will refer as the scientific sector to researchers working in academic institutions, the political sector as members of governmental institutions of any level with decision-making power on public affairs, and the society sector as lay people who are not part of the other two and have decision-making power on public and private affairs. It is worth noting that all of them show some degree of internal heterogeneity, as within each of them social actors may have different interests, values and power. Nonetheless, their internal similarities are more relevant for this analysis.

3.1.1. Engagement

The first aspect to consider is the reasons and ways in which the members of a sector engage in a particular socio-environmental problem related to ES supply or regulation, or benefit capture (Table 1). In spite of the different motivations of each sector, it is possible to find opportunities to common views and objectives. Regarding this, the scientific sector can have an important role in making complex socio-environmental problems visible (Donadio, 2009; Gurvich et al., 2009; Paruelo 2009), although it is necessary to consider and balance the interest and needs of different stakeholders as well (Jax et al., 2018). For this reason, mutual recognition and credibility is a key factor in this level of analysis (Roux et al., 2006). This is a big challenge in Latin America, where the mutual mistrust and prejudices that sometimes exist among sectors, can be higher in a context of a poor scientific system development and/or high levels of corruption.

3.1.2. Understanding

Socio-environmental problems are understood in quite different ways by the three sectors, and even among different actors within each of them (Raymond et al., 2010) (Table 1). Scientific knowledge may be poorly valued by society, as it was illustrated by Marone and González del Solar (2006) for Argentina, Lavado et al. (2011) for Chile, and Ciocca and Delgado (2017) for other countries of Latin America, reducing its potential to influence on public policy design. The need to incorporate other forms of knowledge is increasingly recognized as well, moving forward from its linear transfer from science to policy to its co-production among stakeholders (Fernández, 2016; Posner et al., 2016). This is of evident importance in Latin America, given its cultural diversity, as it was stated in recent reports for the region (Rice et al., 2018).

3.1.3. Language

One of the key aspects of relationships between sectors and knowledge sharing is the language that is used by each of them (Table 1). This is usually identified as a major obstacle in transdisciplinary research and knowledge transfer from academia to policy makers and society (Cash et al., 2003; Dilling and Lemos, 2011; Toomey, 2016). Scientific language is normally identified as the pinnacle of complexity and level of codification (Roux et al., 2006). ESA has its own jargon, which indeed leads to divergent views about how the human-nature relationship is interpreted and communicated (Schröter et al., 2014; Díaz et al., 2018). Nonetheless, it cannot ignore that there is great complexity in the language used in policy-making environments, specifically in what refers to laws and other normative issues. In some cases, conflicts of interest among stakeholders are solved through

Table 1
Characterization of three sectors associated to Ecosystem Services (ES) management according to seven criteria.

	Definition	Scientists	Political sector	**Society**
Engagement	Reasons and ways of engagement as a social actor in a given socio-environmental problem associated to ES (e.g. exposure to floods)	Engagement through research projects. Research subject selected because of: a) Academic interest b) Funding opportunities (Núñez et al., 2009) c) Information demand d) Work-group trajectory (Balvanera et al., 2017)	1) The State is, in some cases, the responsible for the administration of natural resources and people wellbeing 2) Interest in a socio-environmental problem is influenced by social pressures and electoral purposes (Saarikoski et al., 2017).	1) Engagement with a problem as an affected or affecter of ES 2) Interest on a problem arises by direct experience, cultural values, geographic proximity 3) Urban and rural populations show differences in the type and extent of engagement, and both are influenced by mass media coverage (Scheffer et al., 2003, Paruelo et al., 2011)
Understanding	Comprehension of the characteristics, causes and consequences of a socio-environmental problem (e.g. ways that a citizen or a scientist understands floods).	1) Explicit knowledge (Roux et al., 2006) 2) Seeks cause-effect relationships by means of biophysical and social mechanisms 3) Knowledge is not always easily available or understandable for other sectors	1) Gathers, synthesizes and uses knowledge provided by other sectors, with possible bias in their valuation and incorporation (Dilling and Lemos, 2011; Brunet et al., 2018) 2) Understanding of the socio-environmental problems is related to impacts on people, and political costs and benefits that this may carry (Ruckelshaus et al., 2015)	1) Tacit knowledge (traditional/indigenous), intuitive causal relations (Roux et al., 2006) 2) Associates changes in natural capital directly to their wellbeing (Ruckelshaus et al., 2015)
Language	Type and level of codification of the language used within the sector (e.g. scientific, legal, colloquial languages)	1) High level of codification 2) Difficult to translate to other sectors	High level of codification and specificity in legal terms	1) Imprecise colloquial language 2) Not constrained by the necessity to rigor of other types of language
Time lag	Time elapsed between problem awareness and engagement	1) Fast adoption of new conceptual and methodological frameworks (Scheffer et al., 2003) 2) Slower response to demands from sectors outside academia to provide applied research.	1) Reactive response according to magnitude and urgency of the problem and pressures from social actors (Scheffer et al., 2003; Saarikoski et al., 2017) 2) Proactive response when the problem is associated to economic activities 3) Dependent on how the demand is channeled (legal, social protest, lobby, international agreements)	1) Reactive response according to magnitude and urgency of the problem (Scheffer et al., 2003) 2) Proactive response to chronic local problems 3) Dependent on social capital, opinion leaders and mass media (Scheffer et al., 2003)
Time	Time from engagement to action results	1) Long times characteristic of scientific research 2) The search for certainty and consensus extends the time to provide a response or a standpoint at the scientific community level	1) Relatively short times constrained to government terms 2) Institutional instability in Latin America limits the possibility of continuity in long-term plans (Levitsky and Murillo, 2012)	1) Dependent on social capital (Auer et al., unpublished results) 2) Loss of momentum can be critical for participation and to reach goals (Scheffer et al., 2003)
Competence/ agency	Expertise, spatial scale at which the sector can intervene, financial and technical resources	1) Information with varying degree of adaptation to final users (Pielke, 2007) 2) Mainly theoretical solutions, at any spatial scale 3) Resources mainly destined to research and extension 4) Pressures to publish results may reduce time dedicated to policy relevant products (Olander et al., 2017)	1) Top-down regulations or incentives 2) Interventions at specific scales related to the institutional level (national, provincial, county) with or without horizontal and vertical integration (Tompkins and Adger, 2003; Hein et al., 2006) 3) Resources and institutional agency is constrained by technical and financial capacity, which usually decreases the lower is the institutional level (Olander et al., 2017)	1) Individual or collective actions (bottom-up strategies) through mechanisms of society participation: sectoral claims, advocacy by NGO, community management, etc. (Groppo 2014) 2) Individual actions undertaken on private property with own resources. Actions may not comply with the law.
Rewards	Benefits sought by each sector	1) Seeks symbolic capital (Bourdieu, 1979) 2) Self-evaluation of the scientific community makes it conservative about forms of rewards (Kolinjivadi et al., 2017) 3) Engagement in activities outside academia are not always rewarded, discouraging engagement	Measurable results with high impact on society to ensure continuity in political career (Weichselgartner and Kasperson, 2010).	Different components of wellbeing (Saarikoski et al., 2017)

litigation, and then environmental laws can be boycotted with arguments based on legal technicalities (Irvin and Stansbury, 2004). In these cases, where controversies are played in the political and legal arena, rigorous scientific knowledge plays a less important role than that expected by researchers (Pielke, 2007). The society sector is quite heterogeneous regarding language, as it may include individuals with different levels of education and access to information. When these levels are low, the communication deficiencies caused by highly technical language, added to the feeling that their opinions will not be taken into account, are important reasons for the low participation of stakeholders (Diduck and Sinclair, 2002).

3.1.4. Time lag

A socio-environmental problem can be perceived as such and understood by one or more sectors. Still, there is a variable amount of time until each one actively engages in it. We refer to this as time lags (Table 1). The scientific community has a relatively rapid reaction and adopts new theories and conceptual frameworks, being ESA not an exception to this rule (Balvanera et al., 2012; Costanza et al., 2017). Nonetheless, the engagement in more applied aspects is slower and usually depends, among other things, on the socio-environmental problem to be coincident with what is already being studied by the researcher (Dilling and Lemos, 2011; Fischer et al., 2014). The political sector, on the other hand, has to deal with more urgent needs on a day-to-day basis (Saarikoski et al., 2017), so the speed of their engagement is more dependent upon the magnitude and urgency of the problem and the capacity of lobby of the social actor affected by it (McGuire and Silva, 2010). This is a reactive type of response, but also a proactive engagement can take place, which may reduce the inertia. An example of this is the mitigation and adaptation to environmental hazards that affect the prevailing model of development (e.g., floods are managed proactively in a country where economy depends on agricultural production). Finally, the society is believed to have a slow response with sudden shifts in interest on environmental problems. Scheffer et al. (2003) describes a complex combination of mechanisms which determine society's interest, being key factors their social capital and the role of opinion leaders and their credibility. Mass media coverage is also pointed out to have a great effect on public's opinion and engagement, whether increasing or decreasing awareness on environmental problems (Donadio, 2009).

3.1.5. Time

Once an environmental problem is identified and social actors get involved, there is a variable time for each one to provide the response they are capable of (Table 1). There is an evident conflict of interest in this regard, given by the different dynamics of each sector and the lack of habit to get involved in long term actions (Diduck and Sinclair, 2002). This trade-off is quite marked between the science and political sectors. While scientists tend to criticize short-term interests and compulsive actions undertaken by policy-makers, the latter believe that scientists do not provide information in a timely manner (Roux et al., 2006; Fernández 2016; Saarikoski et al., 2017). In addition to natural limited times to the political sector for taking action, Latin America faces a big problem of institutional instability, which hampers long-term plans on environmental issues and others as well. Society has its own pace and, similarly to other sectors, interest may decay and public participation reduced in time demanding processes. It is a continuing challenge to match researcher's, politician's and society's times to tackle environmental problems and reach solutions.

3.1.6. Agency/competence

Each sector has a different agency and competence in the search of solutions to ES supply and benefit distribution (Table 1). Traditionally, the scientific sector is assumed to be an information provider for final users (policy-makers or society), while the political sector is responsible for applying top-down regulations and society to promote bottom-up actions (Bodin and Crona, 2008; Van Der Schoor and Scholtens, 2015). The political sector has a further responsibility of mediating between sectors to agree upon the interventions to be applied, especially when some stakeholder's interests are affected. Members of society can make interventions on their own behalf in private properties, not necessarily complying with existing laws. This is a big and very broad picture, but the socio-political context determines different levels and modes of interaction or participation in decision-making processes (Wesselink et al., 2011). These different interactions accrue to the personal experiences that build environmental values, generating different configurations of networks, agreements or actions according to stakeholder's interests (Davies, 2001) leading to different governance models.

3.1.7. Rewards

Rewards are the benefits that a sector receives, and thus seeks, for its actions. Rewards are of very different nature and respond to the internal dynamics of each sector. They can have a strong influence on all aspects described above, but particularly on engagement and time lag. The institutional setting can lead to a positive or negative feedback between these aspects. For example, if researchers are rewarded only for publishing peer-reviewed articles, they will probably not engage in applied research on environmental problems (Roux et al., 2006). Finally, members of society seek their wellbeing in its different components. It is a continuing claim to the scientific sector to provide information on effect of ES supply change on human wellbeing (Dilling and Lemos, 2011; Cruz-Garcia et al., 2017).

As seen through this characterization, a change is needed in many aspects both in the incentives and the mechanisms for the interaction between sectors, given that the current ones usually do not favor participation in public policy making, being necessary to set clear objectives, follow transparent processes and build trust on institutions (Davies, 2001).

3.2. Sector's interactions influencing ESA mainstreaming

Rather than being separate entities, social actors mutually influence each other as individuals and groups interact, play multiple roles and mobilize from one sector to another. In these interactions lies the potential to break the cognitive barriers identified above, and thus to create favorable conditions for mainstreaming the ESA. What happens in the spaces of interaction among sectors or "interfaces" strongly influence outcomes of ESA mainstreaming (Fig. 1). Interest groups of society can lobby the political sector to reach their objectives, for example large extractive companies lobbying for weaker environmental regulations by the government or, on the contrary, environmentalist NGO promoting stronger regulations (Seghezzo et al., 2011) ("Interest group lobby", Fig. 1). Politicians with vested private economic interests in public affairs that they are supposed to regulate, and thus "sitting at both sides of the desk", are a pervasive example of a kind of interfacing role that is detrimental to sustainable ES management (Robbins, 2000) ("Political corruption", Fig. 1). However, interfaces also have the potential for hosting interactions that enable ESA mainstreaming and drive socio-ecological systems towards sustainability. The political sector can apply top-down control, by enacting and enforcing environmental regulations (Fig. 1). Researchers actively engaging with social actors negatively affected by socio-environmental problems can become "issue advocates" (Pielke, 2007) and empower vulnerable people by prioritizing their access to relevant scientific evidence (Nelson and Vucetich, 2009) ("Capacity building" *sensu* Michaels (2009), Fig. 1). Participation of lay people from early stages of the research process increases the legitimacy, salience and credibility of knowledge (Hegger et al., 2012), which are key attributes for ESA mainstreaming into environmental decision-making ("Knowledge co-production", Fig. 1). When interfaces are used beyond knowledge exchange and become effective spaces for negotiating interests among

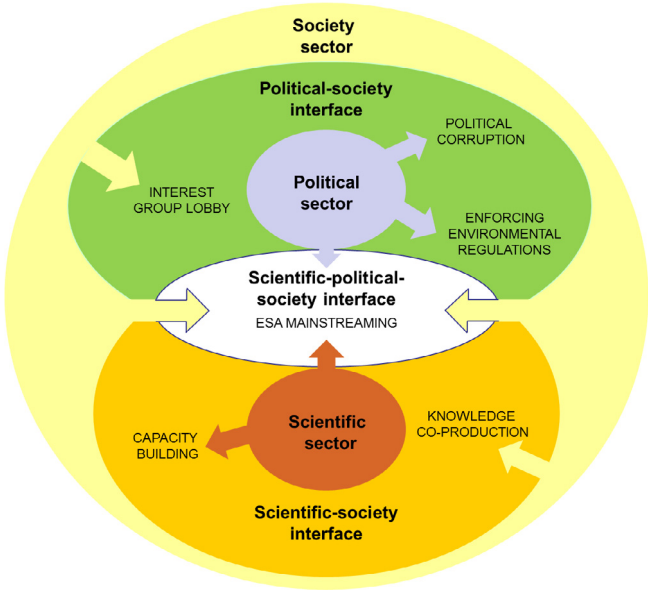

Fig. 1. Interfaces among scientific, political and society sectors, with examples of the multiple diverse interactions that may ensue around environmental problems and their solutions. The political and scientific sectors are relatively small sub-sectors within society, but usually have a significant influence on creating and/or solving environmental problems via synergistic or antagonistic interactions with the larger society. Mainstreaming the Ecosystem Services Approach (ESA) requires synergistic interactions among the three sectors.

diverse social actors, they can engender the co-management of natural resources under the ESA (Berkes, 2009) ("ESA mainstreaming", Fig. 1).

For science to effectively influence policy, mismatches between these sectors must be reduced and boundary agents and organizations play a critical role at the science-policy interface (Guston, 2001; Michaels, 2009). The concept of ES has been proposed to act as a "boundary object" for sustainability by integrating different types of knowledge and enabling dialogue between science and policy sectors (Abson et al., 2014). Boundary agents and organizations are individuals or groups whose role is to reduce the mismatch between science and policy sectors concerning language, knowledge, times, and other attributes of these sectors that usually are not aligned and prevent effective collaboration, as described in the previous section. Researchers become boundary agents when they transcend their role of pure scientists or science arbiters and expand options for action, presenting policy-makers with all possible courses of action and clarifying the consequences that each has to his/her best knowledge. These "honest brokers of policy options" (Pielke, 2007) differ from the "issue advocates" in that they encourage policy-makers to openly assess the diversity of knowledge and values behind each alternative option, without trying to "convince" them about any particular choice.

The complexity inherent in mainstreaming the ESA in policy-making requires collective and concerted action at the science-policy-society interface. This is why boundary organizations, beyond individual agents, become key actors (Liftin, 1994, Lövbrand, 2007). Both governmental and non-government organizations act as boundary organizations in the context of many socio-environmental problems in Latin America. Regional agricultural extension services and agricultural NGOs have been shown to facilitate exchange of knowledge about soil erosion control between scientists and farmers in Costa Rica (Vignola et al., 2013) and Argentina (Manuel-Navarrete and Gallopín, 2011). In turn, meteorological information services, river basin councils and farmer's associations have been shown to act as "boundary chains" that facilitate the bi-directional flow of climate information that is critical for the management of hydrological ES (Kirchhoff et al., 2013; Podestá et al., 2013; Lemos, 2015). Environmental observatories are another good example of boundary organizations in Latin America (Auer et al., 2014). Their objective is to monitor and diagnose natural resources condition through participatory methods, so that information is co-produced and shared among diverse social actors. The information gathered or generated in an *ad hoc* manner is then used to define proposals for policy-making.

3.3. Contrasting models of ESA mainstreaming pathways in the Latin America context

3.3.1. The information deficit model

The resolution of socio-environmental problems associated to ES often requires complex actions from the sectors which were characterized in previous sections. One way of describing the mechanisms for mainstreaming the ESA is to show them as a series of steps in a linear and unidirectional sequence starting from the identification of

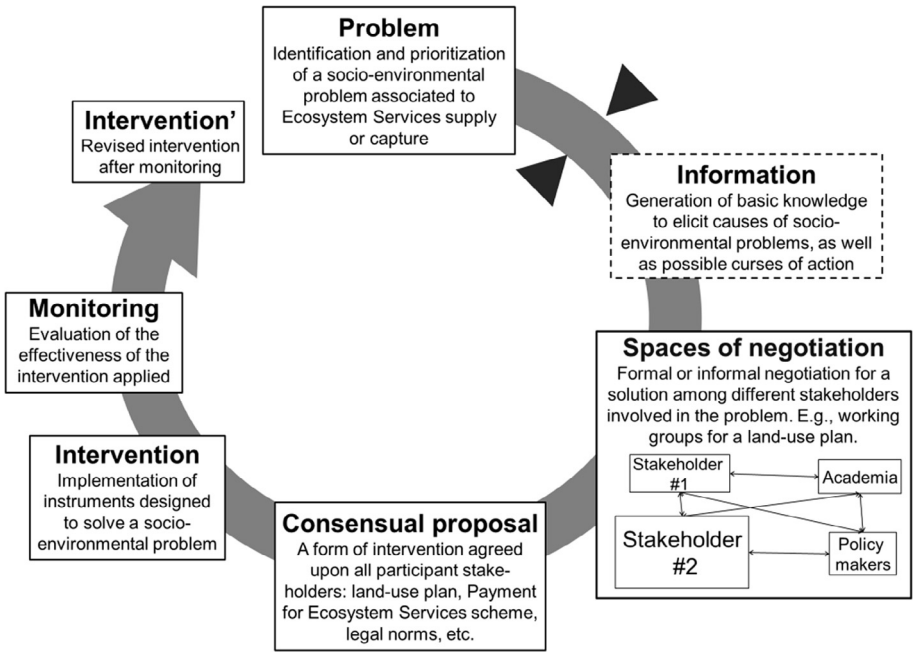

Fig. 2. Linear model of Ecosystem Services management. The black triangles represent a bottleneck in the process caused by a poor knowledge about the causes of the environmental problem. Similar bottlenecks would be found at any of the other steps and make the process fail. Box size of stakeholders #1 and #2 represent their relative power in the space of negotiation given by their economic and/or social capital.

the problem, continuing with the generation of knowledge on their causes and consequences, the establishment of consensus and the implementation of the interventions proposed with a monitoring phase, which leads to adjustments for a new intervention (Fig. 2) (e.g. (Cowling et al., 2008; Prager et al., 2012)).

These models can be broadly described as an information deficit pathway. As such, they assume that lack of sound information would prevent from setting up discussions around causes and consequences of environmental problems and reaching consensus on possible ways of intervention (Fig. 2). Thus, it is claimed that more research would be needed in order to move forward in the management process (Lowe et al., 2006). But the lack of information is not the only cause for the interruption of the mainstreaming process, and "bottlenecks" or "gaps" can be found at any other point (Ruckelshaus et al., 2015).

Far too often, we see that reality does not hold to these assumptions and theoretical promises. The linear and unidirectional flow through the mainstreaming process is but one of many possible pathways. ESA mainstreaming is a path-dependent process in which initial conditions may shape subsequent events, thus leading to different outcomes. On the other hand, it is not at all common that processes of ESA mainstreaming are interrupted because gaps cannot be filled. Rather, these gaps and bottlenecks are circumvented through alternative ways, in which power dynamics and consensus play a critical role (Cáceres et al., 2016). Theory and practice should help us conceptualize a broader set of possible pathways and the most probable ones under certain contexts. Anticipating these pathways would help us find ways of preventing possible conflicts or correcting errors during the ESA mainstreaming processes.

3.3.2. The power dynamics model

Following this model, a problem can be identified by one or more sectors. If it is of high priority for the political or society sectors, and political agenda prevails over scientific evidence, there is the chance that interventions will be undertaken without information nor agreement with the rest of the affected stakeholders (Saarikoski et al., 2017) (Fig. 3). This kind of interventions can be implemented both by governments and members of society (regarding public or private affairs) and represent the worst possible scenario, for having a double risk of not being socially legitimate and at the same time not solving the problem or even creating new ones. A facilitating factor for this type of intervention is the uncoordinated engagement on the socio-environmental problems of different sectors. As we have seen, this is probably more common in contexts of lack of trust among sectors (Dilling and Lemos, 2011), low scientific system development (Gurvich et al., 2009; Ruckelshaus et al., 2015), lack of regulations or willingness to comply with them, or centralized and vertical government structures (Scheffer et al., 2003).

Alternatively, information on causes and consequences of the problem can be generated or synthesized, to envision possible solutions (Fig. 3). Commonly, generation of information relies on the scientific community (Pielke, 2007; Gurvich et al., 2009; Paruelo 2016). But in the absence of mechanisms that facilitate information transfer to policy makers and practitioners (e.g. boundary organizations and knowledge brokers) and with a system that encourages peer reviewed publications over process technologies, it is likely that the information only redefines problems, circulating among researchers (Paruelo, 2009; Dilling and Lemos, 2011; Kolinjivadi et al., 2017). Although the definition of problems and the generation of solution-oriented information should be an iterative process (Opdam et al., 2013; Ruckelshaus et al., 2015; Balvanera et al., 2017), a pathologic situation would lead to an endless recirculation where outcomes in society and policy making are never produced. Another usual cause to the lack of usable knowledge generation is some sort of reluctance of the scientific community to state positions on socio-environmental problems before total precision, certainty and consensus are reached (Scheffer et al., 2003; Castella et al., 2014; Keeler et al., 2017).

It could be considered that information is a sufficient condition for an intervention on a socio-environmental problem. That would be the case of a technocratic intervention based on sound information but not agreed upon the involved stakeholders (Fig. 3). It is interesting to point that, as in the previous case, this intervention can be implemented by different sectors and with different environmental consequences, not always negative. For instance, green grabbing, the set aside of land for conservation without local agreement, can be effective in terms of ES supply, but benefits would not be available for their capture by local stakeholders. That would delegitimize the intervention and generate an adverse reaction to it (Fairhead et al., 2012; Busscher et al., 2018). Another example can be found in some ES interventions such as PES or REDD + that are usually decided hierarchically rather than through participatory processes.

A strong institutional development, with technical and financial capacities, can facilitate the establishment of spaces of negotiation between stakeholders (Fig. 3). Expectedly, these spaces will include stakeholders with different points of view and interests and, likely, with

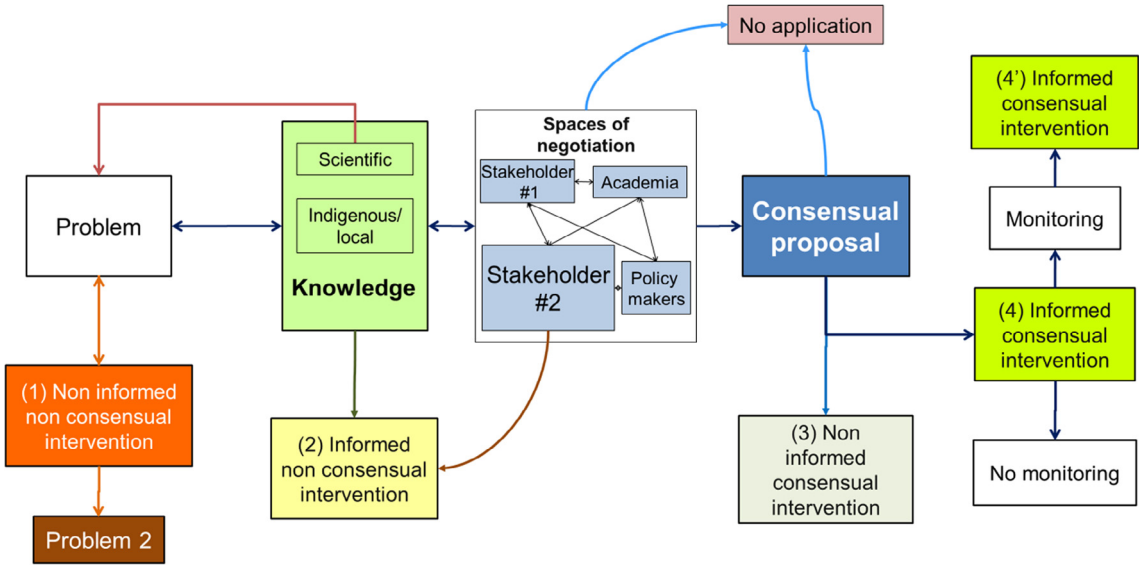

Fig. 3. Pathways of Ecosystem Services management under the power dynamics model, with their different possible outcomes. Box size of stakeholders #1 and #2 represent their relative power in the space of negotiation given by their economic and/or social capital.

Table 2
Synthesis of case studies in Latin America that exemplify the different characteristics of and interactions among sectors and the pathways of ESA mainstreaming.

	Southern Cone Grasslands Conservation	Ejidos of the Ayuquila River middle basin	Water governance in the commune of Panguipulli	Rio Grande basin management
Main socio-environmental problem targeted	Loss of natural grasslands of the Pampas region	Land-use change	Water supply and regulation, access to benefits	Land-use change, water regulation and supply
Main source of knowledge about the problem	The knowledge was generated by the academic sector of different universities	Scientific and traditional/ indigenous	Scientific, no incorporation of local knowledge, although stakeholders visualized the problems.	Scientific, local communities and key stakeholders also participated in the zonification process
Scientific-political sectors interfaces	Grassland Alliance, promoting the enacting of a law for the governmental conservation incentives	Scientists collaborated in the design of public policy	Researchers allied with Bosque Modelo, an entity in which government representatives participate. Bosque Modelo proposed research topics to make results usable. Other activities were oriented to empower of local communities.	Basin Council and research projects carried out through alliances between private sector and public universities and local environmental authority
Scientific-society sectors interfaces	Grassland Alliance, carrying pilot studies in farms, outreach, ..	Scientists collaborated with management proposals to be used as input for discussions among stakeholders	Researchers through outreach activities and responding to specific demands like valuing local natural medicine products	River Basin Council. Research projects carried out through alliances between productive sectors or NGOs and universities
Role of scientists in the interfaces (sensu Pielke, 2007)	Scientific arbiters and Issue Advocates	Honest brokers of alternatives	Pure scientists and Issue Advocates	Pure scientists and Honest brokers
Vertical and horizontal integration among stakeholders and government levels	Good horizontal integration to set common goals and instruments of intervention across four different countries	There were problems of coordination between actions of different governmental levels	Deep conflicts among stakeholders regarding water use rights and governance. Conflicts are especially intense between local communities and State and hydroelectric companies.	Lack of coordination during the elaboration and implementation of Land Use Plan instruments, and lack of dissemination of academic research results. Local population unaware of public policies and instruments of territorial planning.
Intervention instruments applied or envisioned	Payment for Ecosystem Services	Payment for Ecosystem Services, Best Practices Management	Payment for Ecosystem Services	Payment for Ecosystem Services and River basin Planning (land use plan), territorial analysis focused mainly on erosion control and water supply
Acceptability of the instruments by stakeholders	Good, given that the instrument was proposed by the stakeholders and well received in the political sector	Interventions relatively well accepted but problems of mutual trust aroused	Not accepted by the indigenous communities as it contradicts their values. Also the National Forestry Corporation could not find ways of making the information generated by researchers usable.	There was a lack of consensus on the proposed land use plan instrument (e.g. zoning for ES protection). More consensus in Payment for Ecosystem Services
Existence of consensus, facilitation by spaces of negotiation	There was consensus between farmers and conservationist NGOs to set common goals of cattle production and biodiversity conservation. There was also consensus among all stakeholders in the instrument to be applied	Consensus was facilitated by the information provided by researchers to local and regional actors	Water governance left to market, leaving little room for negotiations	Few and incipient spaces of negotiation and public participation processes. Interventions of these spaces (Basin Council) are disconnected and run in the short term, and territorial vision is subjected to government periods (4 years), thus suffering discontinuities.
Pathway of ESA mainstreaming	No application after consensus	#1 in the initial interventions, #4 for subsequent interventions	Generation of information with no application due to lack of consensus among stakeholders and low penetration of the ESA.	#2 (Land Use Plan) and #4 (Payment for Ecosystem Services)

different ability to negotiate. It has been demonstrated in numerous case studies that, in these contexts, knowledge alone cannot be an arbiter to settle discussions (Pielke, 2007; Saarikoski et al., 2017). On the contrary, power relations are being increasingly recognized as key factors at this stage of the process (Berbés-Blázquez et al., 2016; Kolinjivadi et al., 2017). For this reason, spaces of negotiation can fail and dissolve, thus no proposal is reached (Fig. 3), or the social actor with greater power acts outside the space and influence to impose its own interests. This is a very common pathway in Latin America, given the high inequity among social actors and weak institutions (McGuire and Silva, 2010; de la Torre et al., 2017). For example, during discussions about the design of land-use plans mandated by the Law for the Protection of Native Forests of Argentina, large scale farmers walked away from spaces of negotiation and influenced politicians to accept their own proposals (Seghezzo et al., 2011; Cáceres et al., 2016; Cabrol and Cáceres, 2017). This situation leads to the same typology of intervention described above, namely informed and non consensual (Fig. 3).

Even when conflicts between social actors are settled in the space of negotiation, there is still the risk that no proposal is reached. This can happen if the process extends for an excessive period of time, discouraging the participation of society (Diduck and Sinclair, 2002; Irvin and Stansbury, 2004; Ruckelshaus et al., 2015; Rubio et al., 2017; Saarikoski et al., 2017), but also of researchers, who are in most cases pressed by their hiring institutions to show indicators of productivity different than the products of a management process (Podestá et al., 2013).

The most desirable pathway in an ESA mainstreaming process may be an intervention proposal that is both informed and agreed upon (Fig. 3). An important aspect in this last step is that the proposal is technically and financially feasible (Olander et al., 2017). This may be a limitation for many low administrative levels (municipalities, provinces, etc.). For example, the Law for the Protection of Native Forests of Argentina, mandates the provinces to design a land-use plan following strict protocols, which some of these provinces found it difficult to follow due to technical impediments (García Collazo and Paruelo, 2014, Aguiar et al., 2018). Still, local actions can be sometimes more effective than large scale policies, as stakeholder participation and tangible actions are more probable to attain (Opdam et al., 2013). Vertical integration of government institutions may help overcome limitations of those of lower level. Horizontal integration may help as well to share experiences and learn of them.

A mainstreaming process does not necessarily start with the identification of a problem and continues with information generation and discussion of alternative interventions. In fact, the type of intervention can be a starting point, from which *ad hoc* information is generated and spaces of negotiation are set to discuss and apply it. For instance, a PES scheme or a land-use plan can be the foreseen goals of some stakeholders; especially, when this form of interventions serves to their own interests. The information can be generated afterwards and constitute part of the process. However, if information is not requested to design the intervention, then a consensual but not informed intervention would be applied (Fig. 3). This is the opposite situation of intervention #2, i.e. the process is seen as a pure political negotiation where information is not taken into account. Predictably, these interventions will have lower probability to raise social conflicts in the short term, but its effectiveness is dubious.

3.4. Case studies

In this section, we describe four case studies that illustrate different pathways of ESA mainstreaming in relation to different environmental problems, in distinctive contexts of Latin America. These cases show how particular characteristics and interactions among sectors influence the pathways and outcomes of inter-sectoral efforts for mainstreaming ESA.

3.4.1. Governmental economic incentives for the conservation of Southern Cone Grasslands (Argentina, Brazil, Paraguay, Uruguay)

The productive potential of the Southern Cone Grasslands has led to their transformation for agro-livestock use since their colonization by the Europeans. More recently, as a consequence of the expansion of soybean crops and pine and eucalyptus plantations, such transformation has intensified and caused negative impacts on grassland biodiversity and ES supply (Medan et al., 2011; Herrera et al., 2014) as well as social problems (such as rural depopulation or loss of cultural identity) (Auer et al., 2017).

Under this situation, a project began in 2012 with the objective to promote the conservation of natural grasslands through the implementation of a PES scheme by the governments of the region (Parera et al., 2012) (Table 2). The aim was to compensate cattle ranchers that conserved natural grasslands on their farms. This project was led by the "Southern Cone Grasslands Alliance", a regional initiative that tries to promote the conservation of natural grasslands since 2006 and it was led by the NGO BirdLife International and executed through local NGO partners like Aves Argentina, Guyra Paraguay, SAVE Brasil and Aves Uruguay. This alliance acted as a boundary organization to discuss and set common goals between environmental NGOs, cattle ranchers and academics. The main stakeholders involved in this case (cattle ranchers, environmental NGOs, provincial and national governments of four countries, and researchers from different universities) were included from the beginning of the project and agreed upon the instrument proposed to promote grassland conservation.

One of the particular objectives of the project was to build a technical tool to objectively evaluate and quantify the rancher's contribution to grassland conservation, so it could be used to estimate the amount of their economic compensation. To generate this tool, a group of experts from different universities in Argentina, Uruguay and Brazil was convened. In a first stage, existing knowledge was synthesized in an *ad hoc* index (Grassland Conservation Index, or ICP in Spanish), applicable across the region (Parera and Viglizzo, 2014). Subsequently, technicians from political institutions were trained for the use of the ICP in the field and two pilot tests were carried out surveying more than 100,000 hectares of farms in the four countries. The payment scheme envisaged to include the use of the same ICP, with the freedom to adapt the operationalization of the PES to the local context (amounts of payments, origin of funds, adaptation to legislation or previous incentives) (Sarno, 2012).

The intervention only reached the level of pilot tests for training the technicians and the partial approval of a provincial law in Argentina (Santa Fe province). In the other participating countries, the ICP is now used as a tool for the evaluation of the grassland biome and to evaluate rural development projects. However, in no case payments where effectively done. One of the main reasons for this was the end of the government term and the subsequent change in authorities and their priorities in policy making. This led to the initiative losing momentum; even though the whole process of building the index, carrying out pilot tests and lobbying policy makers for its use was really fast (2 years). In spite of this result, it can be pointed out as one of the main strengths of this process the existence of social capital and previous consensus among stakeholders to visualize a form of intervention for grassland conservation. The existence of a boundary organization and knowledge brokers was key to build this social capital. Another positive and unusual characteristic was that efficient regional coordination to pursue a common objective transcending political boundaries.

3.4.2. Ejidos of the Ayuquila river middle basin (Mexico)

The agrarian communities (ejidos) of the Ayuquila river basin in the State of Jalisco had been affected by the transformation of dry tropical and temperate forests to non-forestry land uses such as cattle ranching and the cultivation of agave (raw material for the production of tequila and mezcal (Morales-Barquero et al., 2015) (Table 2). Cattle ranching is carried out by local people of the ejidos, practiced in a slash-and-burn

rotation system (Salinas-Melgoza et al., 2017). Meanwhile, the transformation to agave crops is more recent and is driven by large companies of tequila and mezcal. The Ayuquila river basin is a highly marginalized region in socio-economic terms (CONAPO, 2010), resulting in a strong dependence of local populations on the ES provided by their territories (like water provision, fodder production, fish provision, among others).

At the national level, several public policy instruments have been designed to mitigate anthropogenic impacts on the ecosystems of the region. However, these instruments did not incorporate characteristics of the local socio-ecological conditions. As a result, policy makers were not able to understand the drivers of the ecosystems transformation over which actions should be undertaken. These policies illustrate the pathway #1 of ES mainstreaming (Fig. 3), i.e. uninformed interventions.

For this reason, several local actors began a process of joint information generation to understand the relationships within the socio-ecological system. The work was carried out through various techniques. Some of them were carried only by researchers and for academic purposes (such as land covers maps, forest biomass and carbon reservoirs assessments), while others involved local actors (ejidal governments, NGOs, cattle ranchers, farmers and technical advisors of the National Forestry Commission, representing the political sector) (Larrazábal et al., 2012; Borrego and Skutsch, 2014). The process was organized and lead by an academic team from the Center for Research in Environmental Geography (National Autonomous University of Mexico) and the University Center of the South Coast (University of Guadalajara). Researchers generated data through measurement and cartography with remote sensors, while local actors generated their data through participatory cartography. Both data sources were validated in workshops, presentations and meetings.

The information generated was used to identify critical aspects to be considered in the design of sustainable management schemes and public policy instruments. The leading team generated management, restoration and production scenarios. They also proposed evaluation criteria, as well as strategies for strengthening local capacities in management, monitoring and generation of cartography. At the local level, the information generated was shared with all the actors involved and part of this information facilitated reaching consensual proposals in the form of planning and management processes in the agrarian communities driven by the ejidal governments and technical advisers. At the regional and national level, the information was used in the implementation of actions such REDD+.

At each of these levels (local, regional and national); the spaces of negotiation were flexible (in terms of objectives and tools) and open to traditional knowledge. The information of management decisions was more easily adopted at local level. The information was agreed upon and the proposed actions negotiated with the different actors, but it is still necessary to monitor the effectiveness of these actions. During negotiations and discussions to establish agreements among social actors, mistrust was evident between those with different interests (resource managers vs. government) as it would be expected, but also between those with influence at different scales (local vs. regional). Furthermore, actors of the local governments identified problems of inconsistencies and competences between the instruments of public policy that support agriculture development and those that support and promote conservation. This shows the relevance of coordination among and within sectors for an effective environmental management, a challenge that is greater when there are special forms of local governance.

3.4.3. Water governance in the commune of Panguipulli (Chile)

Panguipulli is a municipality in the Andes Range of Los Ríos region. It covers an area of 3292 km^2 of mainly rural land. It comprises 21% of the region's total native forest area. Thirty percent of the population belongs to the Mapuche ethnic group (INE-MIDEPLAN-BID, 2005). Mapuche cultural influence has been marked in this area, due to the economic and productive worldview that in both cases, comes from what the land offers to them, cultivating food for self-consumption and marketing very reduced amounts during the summer months (Lecaros, 2013).

Chile was the first Latin-American country to engage with neoliberalism (Carruthers, 2001) under a dictatorship regime (1973–90), which largely left environmental governance to the market (Budds, 2013; Holmes, 2015). That is the reason why Panguipulli has been the scene of strong socio-environmental conflicts surrounding water claims, where Mapuche indigenous communities and hydroelectricity plants are the key confronting actors (Carruthers and Rodriguez, 2009). This is why Chile and its Southern territory provide a relevant context for environmental governance studies.

A group of researchers from the Universidad Austral de Chile engaged in exploring limitations to the governance of water provision and regulation in Panguipulli. This approach illustrates the initial stages of the ESA mainstreaming process, that is, knowledge generation to understand the governance systems, its limitations and potentials to visualize appropriate forms of interventions. The evidence revealed that the concept of ES has not been mainstreamed within the institutional or legal framework. Regarding water provision in particular, the view that prevails is that water is a natural resource disconnected from other components of the socio-ecological system (e.g., forests), leading to a sectorial rather than an integrated management. Achieving cooperation and effective coordination among sectors and agents in such divided context is a core problem for environmental governance and ESA implementation.

Predictably, the administrative focus is on access to water and its most efficient use, vision that has led to a very high concentration of water rights by energy, forestry, agricultural and water utilities companies. This market structure may become a critical issue for the implementation of ES based arrangements, such as PES. These mechanisms require benefits appropriability by recognized users and beneficiaries, which cannot be guaranteed in a market system where any buyer can acquire rights despite his/her status as recipient of benefits. In this case study, spaces of negotiation are left to the market, with little intervention of academia and public policy makers. PES implementation is unlikely to be a consensual proposal (pathway #4, Fig. 2) under this institutional arrangement.

Other important issues relate to values and meanings. For indigenous communities it is difficult to internalize the logic of privatization of nature and water. The concept of ES is foreign to them and has not served to enable different stakeholders to develop a common language around conservation of forests and water. Some indigenous representatives reject the use of the term ES based on notions of commoditization of nature and their concern regarding implications related to their current claims (Nahuelhual et al., 2018b).

The researchers group aimed at positioning the concept of ES as an additional conservation criterion. Thus they targeted agencies in charge of technological transfer programs (agriculture and forests based) and local health organizations, and produced education programs, documentaries ("Here, we are forests and water (Aquí somos bosque y agua)", https://youtu.be/4Wj8LAZgAgo) books and other outreach activities. Despite these efforts, the ES concept was not sufficiently internalized among local communities due to the cultural and institutional context described above. This challenges the idea of ESA as a universal strategy to tackle socio-environmental problems.

3.4.4. Rio Grande basin management (Colombia)

Land cover changes associated with agriculture and livestock farming have impacts on soil properties threatening ES such as erosion control and water provision among others (Berrouet et al., 2018). These intense changes associated with economic activities are common across Latin America (Piquer-Rodríguez, 2017). In Colombia, the provision of water for the second largest urban center in the country (Metropolitan

Area of Aburrá Valley –AMVA- with approximately 4 million inhabitants) highly depends on a basin in which agriculture and cattle farming for milk production have transformed a big portion of its land cover to pasture. The Rio Grande basin is located in the state of Antioquia with a population of more than 68,000 and covering an area of 1280 km^2. The predominant land cover is pasture and the main source of income of rural communities is dairy farming, poultry and pig farming, as well as agricultural activities such as growing potatoes, tree tomatoes and coffee (CORANTIOQUIA-UNAL 2012, 2015). A large water reservoir (the Río Grande II) supplies water and energy to 32% of the population of the AMVA. The basin is a source of livestock products for different areas of the country and has a growing tourism potential. Rio Grande basin can be divided into four regions according to socio-economic, cultural and conservation status. In two of them (Northwest and Northeast), different types of interventions are being implemented (Table 2).

The Northwest region includes part of a strategic Páramo ecosystem with high conservation of native vegetation and high levels of water resources. This region is protected through an Integrated Management District (DMI for its acronym in Spanish) conservation tool. For determining compatible land uses within the DMI a zoning was proposed by the local environmental authority. Although there was consensus about the importance of the conservation tool, the zoning was not accepted by local communities. Thus, this region faces the difficulty of lack of agreement about implementation strategies, illustrating pathway #2 (Fig. 3).

Given the biophysical characteristics of the Northwest region, two PES schemes have been introduced (Cuenca Verde and BanCO2, http://www.banco2.com/), implemented by two different organizations. They differ in design and land plots selection criteria. The articulation of academic institutions in the design, implementation and evaluation of these schemes has been incipient so far, but are exemplary of a pathway #4 (Fig. 3), were both information and consensus exist.

In the Northeast region of the basin the native vegetation is well conserved and there is presence of local community environmentalist organizations: Local System of Protected Areas (SILAP Santa Rosa de Osos for its Spanish acronyms), which aims at facilitating the consolidation of protected areas as central element of territorial planning in the Municipality. In the formulation of SILAP and its operation there were knowledge brokers who advised local community and linked it to the local environmental authority. This is also a recent initiative that was adopted in 2017.

In addition to the mentioned local plans, a regional planning instrument has been led by government authorities and local actors of the Rio Grande basin with the purpose to conserve and guarantee the supply of water. This planning instrument is called POMCA by its acronym in Spanish (Plan de Ordenamiento y Manejo de Cuencas hidrográficas). The actors involved in these actions (government authorities, environmental authority, community organizations, NGOs, farmers, private companies, public and private universities) are represented in the basin council, a space of negotiation that allows implementing, in a concerted and coordinated manner, the strategies proposed in the plans (CORANTIOQUIA-UNAL, 2015). In this case, the academic sector (public and private universities) identified key properties and attributes for hydrologic regulation, characterized the beneficiaries, uses and demands of the ES under different climate change scenarios. Furthermore, protection areas were proposed for different land-use planning options at the municipal level.

The basin council, as a consultative body, was one of the main strengths of this case study. Nevertheless, some difficulties arose in relation to the articulation and coordination of the council and other levels of government, such as municipalities or environmental authorities, as well as with the other conservation initiatives described at the beginning of the case study (DMI and PES). This highlights the need for articulation among initiatives that are implemented at different scales, showing once again that engagement and agency of different sectors or even within sectors may be contradictory. Even if they represent successful pathways #4 of ESA mainstreaming (Fig. 3), they do not reach their whole potential if are not articulated actions.

4. Discussion

The conceptual analysis carried out in this paper allowed us to elicit how the initial conditions of cultural, social and political context, and the series of events that follow as a consequence of the relationships among sectors of society, strongly influence the ESA mainstreaming pathways in Latin America. The initial conditions of the socio-institutional context can be characterized by means of the particular attributes and interactions that occur among the scientific, political and society sectors. The series of events can be characterized by the actions that generate and incorporate information and/or social consensus to the process of ESA mainstreaming. The identification of these two mains components (information and consensus) allowed us to visualize which aspects should be considered for a more effective mainstreaming of the ESA, foreseeing the challenges and opportunities in the Latin American context.

4.1. The role of information in ESA mainstreaming

Researchers coincide that production of information regarding the links between ecosystems conditions and ES supply remains a continuing challenge (Bennett et al., 2015; Costanza et al., 2017; Laterra et al., 2017). It is also needed a deeper understanding of the link between ES and human well-being, which is commonly assumed, but not tested through experimental studies (Cruz-Garcia et al., 2017). The challenge may be greater in a highly diverse region as Latin America with multitude of ecosystems, some of them not very well studied so far (Schmidt and Seppelt, 2018). Many of the translations of ecosystems functions to ES are based on “conventional wisdoms” without a serious and continued monitoring effort to understand the ecological processes associated. Then, questions that are important to mainstream the ESA into policy making, like which are the thresholds of acceptable ecosystem change remain largely unanswered.

It is important to incorporate sound information in decision-making, particularly in initial phases of the ES management process (Dieguez et al., 2014), to avoid taking uninformed actions that could increase socio-environmental problems. But there are barriers for information uptake by final users, like the technical jargon that is used in scientific environments. This was illustrated by the low uptake of the ES concept in Panguipulli commune. Thus, a great effort on the part of researchers will be needed to translate technical terms to common and accessible language (Cash et al., 2003; Jax et al., 2018). However, it is important to point that it is not only a problem of terms used, but the values and meanings they imply. In this respect, it is worth mentioning the efforts that are being undertaken by initiatives like IPBES to redefine and adapt concepts to other world views (Díaz et al., 2018).

The source of information can be both scientific and indigenous/traditional (Agrawal, 1995; Berkes et al., 2000; Klooster, 2002). The cultural asset of Latin America gives the opportunity to co-produce valuable knowledge with academia (see for example Betancourt Arellano and Nahuelhual Muñóz (2017). There are many different forms of including social actors that proved successful in the region, among them community monitoring as a form of citizen science (Larrazábal et al., 2012; Podestá et al., 2013; Balderas Torres and Skutsch, 2015; Ortega-Álvarez et al., 2016; Schröter et al., 2017). Co-production of knowledge is not always mandatory, as each research question needs specific methods to approach it. Although, when local knowledge is used, it can also have a positive externality, that is to bring legitimacy to the ES management processes in a region where, for historical reasons, mistrust among stakeholders abound (Dilling and Lemos, 2011; Wesselink et al., 2011; Posner et al., 2016; Toomey, 2016; Balvanera et al., 2017). As there are deep epistemic and ontological

differences between scientific and indigenous knowledge, the contribution of disciplines like anthropology may be helpful to bring these two realms together. So far, this contribution has not been extensive, so an effort in interdisciplinary collaboration is needed.

It is important to note, however, that information availability is not always crucial in ES management. In many cases, information exists and is readily available for uptake. In this situation, researchers should not see the biophysical processes that determine ES supply as the most important aspect on which to focus their work (Nahuelhual et al., 2015; Laterra et al., 2016). Institutional and cultural issues become more important for the process and its outcome, as will be discussed next.

4.2. Consensus over values

Latin America is a region of relatively young democracies, with institutional instability, a tendency of lack of commitment with agreements and short-term policies (Levitsky and Murillo, 2012). That is why the construction of consensus is difficult and critical for the success of many ES mainstreaming processes (Paruelo et al., 2014). The construction of a mature and legitimate democracy may be a "slow variable" to change (Walker et al., 2012). Furthermore, Latin America shows a range of different governance modes that coexist with "western democracy" institutions at different scales, for example communal management by indigenous people, ejidos, etc. (Laterra et al., this issue). Across the continent, these forms of governance are not always recognized and legitimated. Case studies in Mexico and Chile showed how these particular forms of governance lead to conflicts for the ES management through consensus and instruments envisioned under ESA. This is particularly critical in indigenous territories with legal mechanisms preventing access to natural resources as both cases exemplified.

It is a continuing challenge to match different forms of governance due to ES particularities, such as their various property right regimes, their transaction dimensions, the values and visions that different stakeholders hold respect to ES and the spatial dispersion of beneficiaries and providers (Bachev, 2009; Loft et al., 2015). These conditions determine to a large extent the feasibility of ESA implementation and ignoring them may limit the comprehension of the factors influencing ES governing, the range of practicable governance modes (e.g., informal, market, private, public), and their efficiency, synergies, and possibilities of progress (Paavola and Adger, 2005; Bachev, 2016).

It was clearly shown how some of the ESA instruments that involve consensus among stakeholders, like PES, have different adequacy to the contrasting contexts of Panguipulli commune and Southern Cone Grasslands. Similarly, other authors found that historical and cultural contexts are important for different aspects of PES programs, like criteria for the selection of participants, types of actors involved, and funding sources (Manson et al., 2013, Grima et al., 2016). Other comparative studies for Latin America showed that PES programs may be in some cases effective in environmental goals, but they commonly lack social equity (access, inclusion in decision-making and distribution of costs and benefits) (Aguiar et al., 2017). As PES continue to be one of the most encouraged forms of ESA mainstreaming under any sociocultural context, it is timely to reconsider their utility (Martin-Ortega et al., 2013; Ezzine-de-Blas et al., 2016; Santos de Lima et al., 2017), Brownson et al., this issue).

To reach consensus, the spaces of negotiation, under any governance mode, must be empowered. Otherwise, they will only serve to the interests of the most influential stakeholders and legitimate already asymmetrical power relations (Groppo, 2014, Auer et al., 2017). AUER MACEIRA. It is important that the decisions taken in the spaces of negotiation are not discarded afterwards by policy makers. As long as it is possible, proposals arising from these spaces should be legally binding. This way, powerful stakeholders would be inhibited from lobbying outside the space of negotiation.

Another key point, and a usually unattended one, is the time that is devoted to negotiations. There is an evident trade-off in this respect, as the process takes a minimum time to provide ES supply assessments, valuations and scenario discussion, which also includes a certain time for stakeholder training (Castella et al., 2014), but if it extends for too long, government terms may end and the mainstreaming process be halted. This situation was exemplified by the Southern Cone Grasslands Conservation project. Social capital that is built among stakeholders before the negotiations take place can facilitate the reduction in times to reach consensus (Molina Murillo et al., 2014).

4.3. Interplay of information and consensus for the mainstreaming of ESA

An emergent property arises from the relationship between information and consensus. Researchers have traditionally assumed that information generation is useful to reach political consensus and compel action (Pielke, 2007). However, it has been well demonstrated that information is a sine qua non condition for the mainstreaming of environmental issues (Stamienzkin et al., 2009; Simonetti 2011; Dieguez et al., 2014; Saarikoski et al., 2017). Information can compel action only in very specific contexts, that is where there are consensus in values and objectives and low scientific uncertainty (Pielke, 2007). The case studies of the Southern Cone Grasslands conservation project and Ayuquila River Basin are examples where there was consensus in values among the main stakeholders involved in the processes. Therefore, the generation of information was a factor that facilitated the mainstreaming of the ESA to tackle the respective environmental problems. However, this is not always the case. This is why discussion around ESA mainstreaming is being oriented to understand the role that values and power relationships play in decision-making processes (Berbés-Blázquez et al., 2016; Cáceres et al., 2016; Kolinjivadi et al., 2017). Certainly, Latin America is a region where there are values and interests at dispute, because of development models that imply wide and profound land-use changes (e.g. agriculture, forestry, and mining) that affect local community's ways of living and natural capital (Piquer-Rodríguez, 2017; Macías et al., 2018). This is why cultural and institutional factors may be more important than information availability in the present context of the region.

As a direct link between information and decision-making cannot longer be sustained as a universal rule, researchers must reconsider their role in ESA mainstreaming. The linear model of knowledge transfer has been widely criticized and proved ineffective both for decision-making (Pielke, 2007) and influencing society as well (Cortassa, 2012). Thus, new approaches should be imagined, suited to the cultural and institutional context in which this information will be uptake, as it has been shown in Section 4.

In a healthy scientific system, a combination pure scientists, science arbiters, issue advocates and honest brokers of policy options can be found (Pielke, 2007). It is even desirable to find them in different stages of the same ESA mainstreaming process, as their roles can be complementary. In the case studies analyzed for this work, a variety of roles were found. In the case of the Southern Corn Grasslands project, the "Grassland Alliance" was an issue advocate, and the researchers hired to develop the grassland conservation index acted as science arbiters. In the commune of Panguipulli, pure scientists who studied the governance of water were in other cases issue advocates, whenever they conducted education and extension programs to internalize the ES concept according to what they considered the best options for the governance of water in the commune. Finally, researchers associated to the Ayuquila basin river project pursued academic interests (pure scientists) but helped to build scenarios for land management that served ejidal governments take their decisions, thus also acting as honest brokers in specific stages. A similar case is illustrated with the researchers that participated in the Rio Grande basin management.

There is a range of options that the researcher can choose, which will depend upon his/her own motivations and the institutional setting that expands or restricts the options available. Whatever the case, the

pure scientist providing information on ES supply as the only option is, in our opinion, not reasonable nor desirable as it does not adequate to the generality of the contexts of Latin America. Creative actions will be needed to stimulate researchers to adopt different roles. Some of these could be the development of skills to communicate scientific concepts in accessible language, the reduction in times to provide information and a revision of the system of rewards for researchers, presently oriented mainly to peer reviewed papers.

5. Concluding remarks

- In the Latin American context, knowledge generation alone will not solve socio-environmental problems. Consensus is as important for ESA mainstreaming, and there is not a direct link between knowledge and consensus. That is why ESA will have to incorporate elements from other conceptual frameworks that deal with power relations and politics.
- The reach of consensus involves aspects of values and governance. It would be desirable that ESA takes into account a broad range of value systems and links with nature. It also would be recommendable to deepen the focus on the institutional arrangement and relationships among sectors in the Latin American context that enable or prevent ESA mainstreaming, as well as forms of governance for which existing instruments under the ESA are not appropriate.
- The effective use of information as an input for discussions to reach consensus would be facilitated working on the interfaces between the sectors associated to ES management. To this end, innovative roles of the researcher in decision-making environments would be imagined.

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Authors main contributions

FW wrote the ms, designed Figs. 2 and 3 and Table 1. MEM wrote Sections 2, 4, designed Fig. 1 and contributed to Sections 1 and 7. ADA contributed to Table 1, Sections 1, 3 and 7. MPB contributed to Sections 1 and coordinated Section 6. LN contributed to Sections 1, 7 and 6.3. AL contributed to Sections 1 and 6.2. AP contributed to Section 6.1. LMBC, CPLG and CVP contributed to Section 6.4. All coauthors participated in the workshop to discuss general criteria, except AP and LMBC who were invited at a later stage.

References

Abson, D.J., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A., Lang, D., Martens, P., Walmsley, D., 2014. Ecosystem services as a boundary object for sustainability. Ecol. Econ. 103, 29–37.

Agrawal, A., 1995. Dismantling the Divide Between Indigenous and Scientific Knowledge. Dev. Change 26, 413–439.

Aguiar, S., Camba Sans, G., Paruelo, J.M., 2017. Instrumentos económicos basados en mercados para la conservación de la biodiversidad y los servicios ecosistémicos en Latinoamérica: ¿panacea o rueda cuadrada? Ecología Austral 27, 146–161.

Aguiar, S., Mastrangelo, M.E., García-Collazo, M.A., Camba-Sans, G., Mosso, C.E., Ciuffoli, L., Schmidt, M., Vallejos, M., Langbehn, L., Cáceres, D., Merlinsky, G., Paruelo, J.M., Seghezzo, L., Staiano, L., Texeira, M., Volante, J., Verón, S., 2018. ¿Cuál es la situación de la Ley de Bosques en la Región Chaqueña a diez años de su sanción? Revisando su pasado para discutir su futuro. Ecología Austral 28, 400–417.

Auer, A.D., Guido, S., Maceira, N., Elverdín, J., 2014. Observatorios ambientales: una herramienta participativa para el monitoreo de procesos de ordenamiento territorial rural. In: J. M. Paruelo, E.G. Jobbágy, P. Laterra, H. Dieguez, M.A.G. Collazo, A. Panizza, eds. Ordenamiento Territorial Rural. Conceptos, métodos y experiencias, Universidad de Buenos Aires, Ministerio de Agricultura, Ganadería Y Pesca, FAO, pp. 248–270.

Auer, A.D., Nahuelhual Muñóz, L., Maceira, N., 2017. Agriculturisation and trade-offs between commodity production and cultural ecosystem services: A case study in the Argentinean Pampas. J. Rural Stud. 53, 88–101.

Bachev, H., 2009. Governing of Agro-Ecosystem Services. Available at SSRN. https://ssrn.com/abstract=1412295.

Bachev, H., 2016. On Defining, Assessing and Governing of Agrarian Sustainability. J. Adv. Econ. Finance 1, 1–20.

Balderas Torres, A., Skutsch, M., 2015. Special Issue: The Potential Role for Community Monitoring in MRV and in Benefit Sharing in REDD+. Forests 6, 244–251.

Balvanera, P., Daw, T.M., Gardner, T., Martín-López, B., Norström, A., Speranza, C.I., Spierenburg, M., Bennett, E.M., Farfan, M., Hamann, M., Kittinger, J.N., Luthe, T., Maass, M., Peterson, G.D., Pérez-Verdin, G., 2017. Key features for more successful place-based sustainability research on social-ecological systems: a Programme on Ecosystem Change and Society (PECS) perspective. Ecol. Soc. 2 (1), 14. https://doi.org/10.5751/ES-08826-220114.

Balvanera, P., Uriarte, M., Almeida-Leñero, L., Altesor, A., DeClerck, F., Gardner, T., Hall, J., Lara, A., Laterra, P., Peña-Claros, M., Silva Matos, D.M., Vogl, A.L., Romero-Duque, L.P., Arreola, L.F., Caro-Borrero, Á.P., Gallego, F., Jain, M., Little, C., de Oliveira Xavier, R., Paruelo, J.M., Peinado, J.E., Poorter, L., Ascarrunz, N., Correa, F., Cunha-Santino, M.B., Hernández-Sánchez, A.P., Vallejos, M., 2012. Ecosystem services research in Latin America: The state of the art. Ecosyst. Serv. 2, 56–70.

Bennett, E.M., Cramer, W., Begossi, A., Cundill, G., Díaz, S., Egoh, B.N., Geijzendorffer, I.R., Krug, C.B., Lavorel, S., Lazos, E., Lebel, L., Martín-López, B., Meyfroidt, P., Mooney, H.A., Nel, J.L., Pascual, U., Payet, K., Harguindeguy, N.P., Peterson, G.D., Prieur-Richard, A.-H., Reyers, B., Roebeling, P., Seppelt, R., Solan, M., Tschakert, P., Tscharntke, T., Turner, B.L., Verburg, P.H., Viglizzo, E.F., White, P.C.L., Woodward, G., 2015. Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. Curr. Opin. Environ. Sustain. 14, 76–85.

Berbés-Blázquez, M., González, J.A., Pascual, U., 2016. Towards an ecosystem services approach that addresses social power relations. Curr. Opin. Environ. Sustain. 19, 134–143.

Berkes, F., 2009. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J. Environ. Manage. 90, 1692–1702.

Berkes, F., Colding, J., Folke, C., 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecol. Appl. 10, 121–1262.

Berrouet, L.M., Machado, J., Villegas-Palacio, C., 2018. Vulnerability of socio-ecological systems: a conceptual Framework. Ecol. Ind. 84, 632–647.

Betancourt Arellano, R.S., Nahuelhual Muñóz, L., 2017. Servicios ecosistémicos y bienestar local: caso de estudio sobre productos de medicina natural en Panguipulli, sur de Chile. Ecología Austral 27, 099–112.

Bodin, Ö., Crona, B.I., 2008. Management of Natural Resources at the Community Level: Exploring the Role of Social Capital and Leadership in a Rural Fishing Community. Word Dev. 36, 2763–2779.

Borrego, A., Skutsch, M., 2014. Estimating the opportunity costs of activities that cause degradation in tropical dry forest: Implications for REDD +. Ecol. Econ. 101, 1–9.

Bourdieu, P., 1979. La Distinción. Criterio y bases sociales del gusto. Traducción de la edición de LEs editions de Minuit, Paris: Mari de Carmen Ruiz de Elvira (1988,1998). Grupo Santillana de Ediciones (España).

Brunet, L., Tuomisaari, J., Lavorel, S., Crouzat, E., Bierry, A., Peltola, T., Arpin, I., 2018. Actionable knowledge for land use planning: Making ecosystem services operational. Land Use Policy 72, 27–34.

Budds, J., 2013. Water, Power, and the production of Neoliberalism in Chile, 1973–2005. Environ. Planning 31, 30–318.

Busscher, N., Parra, C., Vanclay, F., 2018. Land grabbing within a protected area: the experience of local communities with conservation and forestry activities in Los Esteros del Iberá, Argentina. Land Use Policy 78, 572–582.

Cabrol, D.A., Cáceres, D.M., 2017. Las disputas por los bienes comunes y su impacto en la apropiación de servicios ecosistémicos. La Ley de Protección de Bosques Nativos, en la Provincia de Córdoba, Argentina. Ecología Austral 27, 134–145.

Cáceres, D.M., Silvetti, F., Díaz, S., 2016. The rocky path from policy-relevant science to policy implementation — a case study from the South American Chaco. Curr. Opin. Environ. Sustain 19, 57–66.

Carruthers, D., 2001. Environmental politics in Chile: legacies of dictatorship and democracy. Third World Quarterly 22, 343–358.

Carruthers, D., Rodriguez, P., 2009. Mapuche protest, environmental conflict and social movement linkage in Chile. Third World Quarterly 30, 743–760.

Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., Jager, J., Mitchell, R.B., 2003. Knowledge systems for sustainable development. Proc. Natl. Acad. Sci USA 100, 8086–8091.

Castella, J.-C., Bourgoin, J., Lestrelin, G., Bouahom, B., 2014. A model of the science–practice–policy interface in participatory land-use planning: lessons from Laos. Landscape Ecol. 29, 1095–1107.

Ciocca, D.R., Delgado, G., 2017. The reality of scientific research in Latin America; an insider's perspective. Cell Stress Chaperones 22, 847–852.

CONAPO, 2010. Índice de marginación por localidad 2010.

CORANTIOQUIA-UNAL, 2012. Valoración económica, ecológica y socio-cultural de bienes y servicios en al Cuenca del Río Grande: aproximación conceptual y metodológica (No. contrato 8811). Corporación Autónoma Regional del Centro de Antioquia - CORANTIOQUIA.

CORANTIOQUIA-UNAL, 2015. Actualización y ajuste Plan de Ordenación y Manejo de la Cuenca de los Ríos Grande y Chico. Municipios de Belmira, San Pedro de los Milagros, Entrerríos, Santa Rosa de Osos, Donmatías y Yarumal. (No. Convenio

Interadministrativo No. 967 de 2013). Corporación Autónoma Regional del Centro de Antioquia y Universidad Nacional de Colombia Sede Medellín.
Cortassa, C., 2012. La ciencia ante el público. EUDEBA, Buenos Aires.
Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., Grasso, M., 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosyst. Serv. 28, 1–16.
Cowling, R.M., Egoh, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., Wilhelm-Rechman, A., 2008. An operational model for mainstreaming ecosystem services for implementation. Proc. Natl. Acad. Sci. USA 105, 9483–9488.
Cruz-Garcia, G.S., Sachet, E., Blundo-Canto, G., Vanegas, M., Quintero, M., 2017. To what extent have the links between ecosystem services and human well-being been researched in Africa, Asia, and Latin America? Ecosyst. Serv. 25, 201–212.
Davies, A., 2001. What silence knows - Planning, Public Participation and Environmental Values. Environ. Values 10, 77–102.
de Chazal, J., Quétier, F., Lavorel, S., Van Doorn, A., 2008. Including multiple differing stakeholder values into vulnerability assessments of socio-ecological systems. Global Environ. Change 18, 508–520.
de Groot, R.S., Alkemade, R., Braat, L., Hein, L., Willemen, L., 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecol. Complexity 7, 260–272.
de la Torre, A., Messina, J., Silva, J., 2017. The Inequality Story in Latin America and the Caribbean: Searching for an Explanation. In: Bértola, L., Williamson, J. (Eds.), Has Latin American Inequality Changed Direction? Springer, pp. 317–338.
Dempsey, J., Robertson, M.M., 2012. Ecosystem services: Tensions, impurities, and points of engagement within neoliberalism. Prog. Hum. Geogr. 36, 758–779.
Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z., Hill, R., Chan, K.M.A., Baste, I.A., Brauman, K.A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P.W., van Oudenhoven, A.P.E., van der Plaat, F., Schröter, M., Lavorel, S., Aumeeruddy-Thomas, Y., Bukvareva, E., Davies, K., Demissew, S., Erpul, G., Failler, P., Guerra, C.A., Hewitt, C.L., Keune, H., Lindley, S., Shirayama, Y., 2018. Assessing nature's contributions to people. Science 359, 270–272.
Dick, J., Turkelboom, F., Woods, H., Iniesta-Arandia, I., Primmer, E., Saarela, S.-R., Bezák, P., Mederly, P., Leone, M., Verheyden, W., Kelemen, E., Hauck, J., Andrews, C., Antunes, P., Aszalós, R., Baró, F., Barton, D.N., Berry, P., Bugter, R., Carvalho, L., Czúcz, B., Dunford, R., Garcia Blanco, G., Geamănă, N., Giucă, R., Grizzetti, B., Izakovičová, Z., Kertész, M., Kopperoinen, L., Langemeyer, J., Montenegro Lapola, D., Liquete, C., Luque, S., Martínez Pastur, G., Martin-Lopez, B., Mukhopadhyay, R., Niemela, J., Odee, D., Peri, P.L., Pinho, P., Patrício-Roberto, G.B., Preda, E., Priess, J., Röckmann, C., Santos, R., Silaghi, D., Smith, R., Vădineanu, A., van der Wal, J.T., Arany, I., Badea, O., Bela, G., Boros, E., Bucur, M., Blumentrath, S., Calvache, M., Carmen, E., Clemente, P., Fernandes, J., Ferraz, D., Fongar, C., García-Llorente, M., Gómez-Baggethun, E., Gundersen, V., Haavardsholm, O., Kalóczkai, Á., Khalalwe, T., Kiss, G., Köhler, B., Lazányi, O., Lellei-Kovács, E., Lichungu, R., Lindhjem, H., Magare, C., Mustajoki, J., Ndege, C., Nowell, M., Nuss Girona, S., Ochieng, J., Often, A., Palomo, I., Pataki, G., Reinvang, R., Rusch, G., Saarikoski, H., Smith, A., Soy Massoni, E., Stange, E., Vågnes Traaholt, N., Vári, Á., Verweij, P., Vikström, S., Yli-Pelkonen, V., Zulian, G., 2017. Stakeholders' perspectives on the operationalisation of the ecosystem service concept: Results from 27 case studies. Ecosystem Services.
Diduck, A., Sinclair, J.A., 2002. Public Involvement in Environmental Assessment: The Case of the Nonparticipant. Environ. Manage. 29, 578–588.
Dieguez, H., E.G. Jobbágy, S. Torrella, K. Zelaya, L. Machi, M.E. Zaccagini, M. Taboada, 2014. La información en los procesos de ordenamiento territorial. In: J.M. Paruelo, E. Jobaggy, P. Laterra, H. Dieguez, M.A. García Collazo, A. Panizza, editors. Ordenamiento Territorial Rural. Conceptos, métodos y experiencias. Universidad de Buenos Aires, Ministerio de Agricultura, Ganadería y Pesa, FAO, Buenos Aires, pp. 140–149.
Dilling, L., Lemos, M.C., 2011. Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. Global Environ. Change 21, 680–689.
Donadio, E., 2009. Ecólogos y mega-minería, reflexiones sobre por qué y cómo involucrarse en el conflicto minero-ambiental. Ecología Austral 19, 247–254.
Ezzine-de-Blas, D., Wunder, S., Ruiz-Pérez, M., del Pilar Moreno-Sanchez, R., 2016. Global patterns in the implementation of payments for environmental services. PLoS ONE 11, e0149847.
Fagerholm, N., Käyhkö, N., Ndumbaro, F., Khamis, M., 2012. Community stakeholders ' knowledge in landscape assessments – Mapping indicators for landscape services. Ecol. Ind. 18, 421–433.
Fairhead, J., Leach, M., Scoones, I., 2012. Green Grabbing: a new appropriation of nature? J. Peasant Stud. 39, 237–261.
Fernández, R.J., 2016. How to be a more effective environmental scientist in management and policy contexts. Environ. Sci. Policy 64, 171–176.
Fischer, J., Sherren, K., Hanspach, J., 2014. Place, case and process: Applying ecology to sustainable development. Basic Appl. Ecol. 15, 187–193.
Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. Ecol. Econ. 68, 643–653.
García Collazo, M.A., J.M. Paruelo, 2014. Ordenamiento territorial de bosques nativos: Resultados de la zonificación en la Argentina. In: J.M. Paruelo, E.G. Jobbágy, P. Laterra, H. Dieguez, M.A. García Collazo, A. Panizza, eds. Ordenamiento territorial rural. Conceptos, métodos y experiencias. Universidad de Buenos Aires, Ministerio de Agricultura, Ganadería Y Pesca, FAO, pp. 323–362.
Grima, N., Singh, S.J., Smetschka, B., Ringhofer, L., 2016. Payment for Ecosystem Services (PES) in Latin America: Analysing the performance of 40 case studies. Ecosyst. Serv. 17, 24–32.
Groppo, P., 2014. El sistema territorial y los actores: mecanismos de participación y negociación en procesos de ordenamiento territorial. In: J.M. Paruelo, E.G. Jobbágy, P. Laterra, H. Dieguez, M.A. García Collazo, A. Panizza, eds. Ordenamiento territorial rural. Conceptos, métodos y experiencias. Universidad de Buenos Aires, Ministerio de Agricultura, Ganadería Y Pesca, FAO, pp. 232–269.
Gurvich, D.E., Renison, D., Barri, F., 2009. El rol del ecólogo ante la crisis ambiental actual. Ecología Austral 19, 233–238.
Guston, D.H., 2001. Boundary Organizations in Environmental Policy and Science: An Introduction. Sci. Technol. Human Values 26, 399–408.
Hauck, J., Görg, C., Varjopuro, R., Ratamäki, O., Jax, K., 2013. Benefits and limitations of the ecosystem services concept in environmental policy and decision making: Some stakeholder perspectives. Environ. Sci. Policy 25, 13–21.
Hegger, D., Lamers, M., Van Zeijl-Rozema, A., Dieperink, C., 2012. Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action. Environ. Sci. Policy 18, 52–65.
Hein, L., van Koppen, K., de Groot, R.S., van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. Ecol. Econ. 57, 209–228.
Herrera, L.P., Nabinger, C., Weyland, F., Parera, A., 2014. Caracterización de los pastizales del cono sur, servicios ecosistémicos y problemática actual de conservación. In: Parera, A., Paullier, I., Weyland, F. (Eds.), Índice de contribución a la conservación de pastizales naturales del cono sur: una herramienta para incentivar a los productores rurales. Aves, Uruguay.
Holmes, G., 2015. Markets, nature, neoliberalism, and conservations through private protected areas in Southern Chile. Environ. Planning 47, 80–866.
INE-MIDEPLAN-BID, 2002. Estadisticas sociales de los pueblos indigenas en Chile - censo 200..
Irvin, R.A., Stansbury, J., 2004. Citizen participation in decision making: is it worth the effort? Public Administration Rev. 64, 55–65.
Jax, K., Furman, E., Saarikoski, H., Barton, D.N., Delbaere, B., Dick, J., Duke, G., Görg, C., Gómez-Baggethun, E., Harrison, P.A., Maes, J., Pérez-Soba, M., Saarela, S.-R., Turkelboom, F., van Dijk, J., Watt, A.D., 2018. Handling a messy world: Lessons learned when trying to make the ecosystem services concept operational. Ecosyst. Serv. 29, 415–427.
Keeler, B.L., Chaplin-Kramer, R., Guerry, A.D., Addison, P.F.E., Bettigole, C., Burke, I.C., Gentry, B., Chambliss, L., Young, C., Travis, A.J., Darimont, C.T., Gordon, D.R., Hellmann, J., Kareiva, P., Monfort, S., Olander, L., Profeta, T., Possingham, H.P., Slotterback, C., Sterling, E., Ticktin, T., Vira, B., 2017. Society Is Ready for a New Kind of Science—Is Academia? Bioscience 67, 591–592.
Kirchhoff, C.J., Lemos, M.C., Engle, N.L., 2013. What influences climate information use in water management? The role of boundary organizations and governance regimes in Brazil and the U.S. Environ. Sci. Policy 26, 6–18.
Klooster, D., 2002. Toward Adaptive Community Forest Management: Integrating Local Forest Knowledge with Scientific Forestry. Econ. Geogr. 78, 43.
Kolinjivadi, V., Van Hecken, G., Rodríguez de Francisco, J.C., Pelenc, J., Kosoy, N., 2017. As a lock to a key? Why science is more than just an instrument to pay for nature's services. Curr. Opin. Environ. Sustain. 26–27, 1–6.
Larrazábal, A., McCall, M.K., Mwampamba, T.H., Skutsch, M., 2012. The role of community carbon monitoring for REDD+: a review of experiences. Curr. Opin. Environ. Sustain. 4, 707–716.
Laterra, P., Barral, M.P., Carmona, A., Nahuelhual, L., 2016. Focusing conservation efforts on ecosystem service supply may increase vulnerability of socio-ecological systems. PLoS ONE 11 (5), e0155019.
Laterra, P., Martín-López, B., Mastrángelo, M., Garibaldi, L.A., 2017. Servicios Ecosistémicos en Latinoamérica. De la investigación a la acción. Ecología Austral 27, 094–098.
Lavado, M., Palma, L., Cárcamo, M., 2011. Transferencia Tecnológica, Servicios Ecosistémicos y CAPR: Mecanismos de vinculación integral para los diversos actores que conviven en una cuenca: Caso Innova Cuencas APR, Chile. In: Lara, A., Laterra, P., Manson, R., Barrantes, G. (Eds.), Servicios Ecosistémicos Hídricos: Estudios de Caso en América Latina y el Caribe. Red ProAgua CYTED, Imprenta América, Valdivia, pp. 281–296.
Lecaros, G., 2013. Comunidades Mapuche en conflicto con SN Power. Antecedentes de las comunidades del Valle de Liquiñe comuna de Panguipulli frente a una nueva amenaza de hidroeléctricas en territorio mapuche. Universidad Austral de Chile.
Lemos, M.C., 2015. Usable climate knowledge for adaptive and co-managed water governance. Curr. Opin. Environ. Sustain 12, 48–52.
Levitsky, S., Murillo, M.V., 2012. Building Institutions on Weak Foundations: Lessons from Latin America. J. Democracy 24, 93–107.
Liftin, K., 1994. Ozone discourses: science and politics in global environmental cooperation. Columbia University Press.
Loft, L., Mann, C., Hansjürgens, B., 2015. Challenges in ecosystem services governance: Multi-levels, multi-actors, multi-rationalities. Ecosyst. Serv. 16, 150–157.
Lövbrand, E., 2007. Pure science or policy involvement? Ambiguous boundary-work for Swedish carbon cycle science. Environ. Sci. Policy 10, 39–47.
Lowe, K.W., Fitzsimons, J.A., Gleeson, T., Straker, A., 2006. Seeking Mechanisms for Improved Integration of Biodiversity Issues in Regional Natural Resource Management Planning. Australasian J. Environ. Manage. 13, 52–61.
Macías, V.B., Ramírez, J.S., Delgado, Y.M., Córdoba, M., Rubio, A.O., 2018. 84 years of Mexicós land use planning: reflections for biodiversity conservation. Nova Scientia 10, 592–629.
Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A.L., Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L., Bidoglio, G., 2012. Mapping ecosystem services for policy support and decision making in the European Union. Ecosyst. Serv. 1, 31–39.
Manson, R., Barrantes, G., Bauche Petersen, P., 2013. Lecciones de Costa Rica y México para el desarrollo y fortalecimiento de programas de pagos por servicios ambientales hidrológicos en America Latina. In: Lara, A., Laterra, P., Manson, R., Barrantes, G. (Eds.), Servicios ecosistémicos hídricos: estudios de caso en América Latina y el Caribe. Red ProAgua CYTED, Valdivia, pp. 143–167.

Manuel-Navarrete, D., Gallopín, G.C., 2011. Feeding the world sustainably: knowledge governance and sustainable agriculture in the Argentine Pampas. Environ. Dev. Sustain. 14, 321–333.
Marone, L., González del Solar, R., 2006. El valor cultural de la ciencia y la tecnología. Apuntes de Ciencia y Tecnología 19, 36–42.
Martin-Ortega, J., Ojea, E., Roux, C., 2013. Payments for Water Ecosystem Services in Latin America: A literature review and conceptual model. Ecosyst. Serv. 6, 122–132.
McGuire, M., Silva, C., 2010. The Effect of Problem Severity, Managerial and Organizational Capacity, and Agency Structure on Intergovernmental Collaboration: Evidence from Local Emergency Management. Public Administration Rev. 70, 279–288.
Medan, D., Torretta, J.P., Hodara, K., E. B. d. l. Fuente, and N. H. Montaldo., 2011. Effects of agriculture expansion and intensification on the vertebrate and invertebrate diversity in the Pampas of Argentina. Biodivers. Conserv. 20, 3077–3100.
Michaels, S., 2009. Matching knowledge brokering strategies to environmental policy problems and settings. Environ. Sci. Policy 12, 994–1011.
Molina Murillo, S., Pérez Castillo, J., Herrera Ugalde, M., 2014. Assessment of environmental payments on indigenous territories: The case of Cabecar-Talamanca, Costa Rica. Ecosyst. Serv. 8, 35–43.
Morales-Barquero, L., Borrego, A., Skutsch, M., Kleinn, C., Healey, J.R., 2015. Identification and quantification of drivers of forest degradation in tropical dry forests: a case study in Western Mexico. Land Use Policy 49, 296–309.
Nahuelhual, L., Benra, F., Rojas, F., Díaz, G.I., Carmona, A., 2018a. Mapping social values of ecosystem services: what is behind the map? Ecol. Soc. 21, 24.
Nahuelhual, L., Laterra, P., Villarino, S., Mastrángelo, M., Carmona, A., Jaramillo, A., Barral, P., Burgos, N., 2015. Mapping of ecosystem services: missing links among what, how and what for. Ecosyst. Serv. 13.
Nahuelhual, L., Saavedra, G., Henríquez, F., Benra, F., Vergara, X., Perugache, C., Hasen, F., 2018b. Opportunities and limits to ecosystem services governance in developing countries and indigenous territories: The case of water supply in Southern Chile. Environ. Sci. Policy 86, 11–18.
Nelson, M.P., Vucetich, J.A., 2009. On advocacy by environmental scientists: what, whether, why, and how. Conserv. Biol. 23, 1090–1101.
Núñez, P.G., Núñez, C., Morales, C.L., 2009. Práctica científca y fnanciación. Un debate pendiente para la Ecología. Ecología Austral 19, 239–245.
Olander, L., Polasky, S., Kagan, J.S., Johnston, R.J., Wainger, L., Saah, D., Maguire, L., Boyd, J., Yoskowitz, D., 2017. So you want your research to be relevant? Building the bridge between ecosystem services research and practice. Ecosyst. Serv. 26, 170–182.
Opdam, P., Nassauer, J.I., Wang, Z., Albert, C., Bentrup, G., Castella, J.-C., McAlpine, C., Liu, J., Sheppard, S., Swaffield, S., 2013. Science for action at the local landscape scale. Landscape Ecol. 28, 1439–1445.
Ortega-Álvarez, R., Sánchez-González, L.A., Valera-Bermejo, A., Berlanga-García, H., 2016. Community-Based Monitoring and Protected Areas: Towards an Inclusive Model. Sustain. Dev. 25, 200–212.
Paavola, J., Adger, W.N., 2005. Institutional ecological economics. Ecol. Econ. 53, 353–368.
Panizza, A., García Collazo, M.A., 2014. Experiencias de ordenamiento territorial en Iberoamérica. In: J.M. José M. Paruelo, E.G. Jobbágy, P. Laterra, H. Dieguez, M.A. García Collazo, A. Panizza, eds. Ordenamiento Territorial Rural. Conceptos, métodos y experiencias. FAO, pp. 271–300.
Parera, A., Paullier, I., Bosso, A., 2012. Incentivos para conservar los pastizales del cono sur. Una propuesta para gobiernos y productores rurales, Aves Uruguay.
Parera, A., Viglizzo, E., 2014. Índice de Contribución a la conservación de pastizales naturales del cono sur de Sudamérica (ICP): criterios y parámetros para su desarrollo. In: P.A., I. Paullier, F. Weyland, eds. Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur: Una herramienta para incentivar a los productores rurales. Aves Uruguay, pp. 40–55.
Paruelo, J.M., 2009. En relación con el artículo "El rol del ecólogo ante la actual crisis ambiental", de Gurvich et al., en este número. Ecología Austral 19, 255–258.
Paruelo, J.M., 2016. El papel de la Ciencia en el proceso de Ordenamiento Territorial (y en otras cuestiones vinculadas con problemas ambientales). Ecología Austral 26, 51–58.
Paruelo, J.M., L. Herrera, M. Moricz, R. Urrutia, M.E. Zaccagini, D. J. Somma, C. Quispe, G. Giaccio, F. Milano, M. Barreda, D. Ceballos, 2011. Desde la discusión conceptual y metodológica a la acción. El uso del concepto de SE en el proceso de toma de decisiones. In: P. Laterra, E.G. Jobbágy, J.M. Paruelo, eds. Valoración de servicios ecosistémicos. Conceptos, herramientas y aplicaciones para el ordenamiento territorial. Ediciones INTA, Buenos Aires, pp. 689–705.
Paruelo, J.M., Laterra, P., Viglizzo, E., 2014. Captítulo 10. Un plan operativo para incorporar los servicios ecosistémicos en el proceso de ordenamiento territorial. In: Paruelo, J.M., Jobaggy, E., Laterra, P., Dieguez, H., García Collazo, M.A., Panizza, A. (Eds.), Ordenamiento Territorial Rural: conceptos, métodos y experiencias. UBA. Ministerio de Agricultura, Ganadería y Pesca, FAO, Buenos Aires, pp. 159–172.
Pielke, R.A., 2007. The Honest Broker. Making sense of science in policy and politics. Cambridge University Press.
Piquer-Rodríguez, M., 2017. Effects of policies and zoning on future land use in Argentina. Thesis dissertation. Humboldt-Universität zu Berlin.
Podestá, G.P., Natenzon, C.E., Hidalgo, C., Ruiz Toranzo, F., 2013. Interdisciplinary production of knowledge with participation of stakeholders: A case study of a collaborative project on climate variability, human decisions and agricultural ecosystems in the Argentine Pampas. Environ. Sci. Policy 26, 40–48.
Posner, S.M., McKenzie, E., Ricketts, T.H., 2016. Policy impacts of ecosystem services knowledge. Proc. Natl. Acad. Sci. USA 113, 1760–1765.
Prager, K., Reed, M., Scott, A., 2012. Encouraging collaboration for the provision of ecosystem services at a landscape scale—rethinking agri-environmental payments. Land Use Policy 29, 244–249.
Raymond, C.M., Fazey, I., Reed, M.S., Stringer, L.C., Robinson, G.M., Evely, A.C., 2010. Integrating local and scientific knowledge for environmental management. J. Environ. Manage. 91, 1766–1777.
Rice, J., Rodríguez Ozuna, V., Zaccagini, M.E., Bennett, E.M., Buddo, D., Estrada-Carmona, N., Garbach, K., Vogt, N., Barral, M.P., 2018. Chapter 1: Setting the scene. In: Rice, J., Seixas, C.S., Zaccagini, M.E., Bedoya-Gaitán, M., Valderrama, N. (Eds.), IPBES (2018): The IPBES regional assessment report on biodiversity and ecosystem services for the Americas. Secretariat of the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, pp. 4–61.
Robbins, P., 2000. The rotten institution: corruption in natural resource management. Political Geogr. 19, 423–443.
Roux, D.J., Rogers, K.H., Biggs, H.C., Ashton, P.J., Sergeant, A., 2006. Bridging the science–management divide: moving from unidirectional knowledge transfer to knowledge interfacing and sharing. Ecol. Society 11 (1), 4. http://www.ecologyandsociety.org/vol11/iss1/art4/.
Rubio, M.C., Rubio, C., Salomón, M.A., Abraham, E., 2017. Conservation of ecosystem services in high-altitude Andean wetlands: social participation in the creation of a natural protected area. Ecología Austral 27, 177–192.
Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A., Bernhardt, J., 2015. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. Ecol. Econ. 115, 11–21.
Saarikoski, H., Primmer, E., Saarela, S.-R., Antunes, P., Aszalós, R., Baró, F., Berry, P., Blanko, G.G., Goméz-Baggethun, E., Carvalho, L., Dick, J., Dunford, R., Hanzu, M., Harrison, P.A., Izakovicova, Z., Kertész, M., Kopperoinen, L., Köhler, B., Langemeyer, J., Lapola, D., Liquete, C., Luque, S., Mederly, P., Niemelä, J., Palomo, I., Pastur, G.M., Peri, P.L., Preda, E., Priess, J.A., Santos, R., Schleyer, C., Turkelboom, F., Vadineanu, A., Verheyden, W., Vikström, S., Young, J., 2017. Institutional challenges in putting ecosystem service knowledge in practice. Ecosystem Services.
Salinas-Melgoza, M., Skutsch, M., Lovett, J., B. A., 2017. Carbon emissions from dryland shifting cultivation: a case study of Mexican tropical dry forest. Silva Fenn 51 (1B) http://www.silvafennica.fi/article/1553.
Santos de Lima, L., Krueger, T., García-Marquez, J., 2017. Uncertainties in demonstrating environmental benefits of payments for ecosystem services. Ecosyst. Serv. 27, 139–149.
Sarno, R., 2012. Los gobiernos de la región y sus posibilidades de aplicación de incentivos a la conservación de pastizales naturales. In: P. A., Paullier, I., Bosso, A., eds. Incentivos para conservar los pastizales del cono sur. Una propuesta para gobiernos y productores rurales. Aves Uruguay.
Scheffer, M., Westley, F., Brock, W., 2003. Slow Response of Societies to New Problems: Causes and Costs. Ecosystems 6, 493–502.
Schmidt, E., Seppelt, R., 2018. Information content of global ecosystem service databases and their suitability for decision advice. Ecosyst. Serv. 32, 22–40.
Schröter, M., Kraemer, R., Mantel, M., Kabisch, N., Hecker, S., Richter, A., Neumeier, V., Bonn, A., 2017. Citizen science for assessing ecosystem services: Status, challenges and opportunities. Ecosyst. Serv. 28, 80–94.
Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S., Opdam, P., 2014. Ecosystem Services as a Contested Concept: a Synthesis of Critique and Counter-Arguments. Conserv. Lett. 7, 514–523.
Seghezzo, L., Volante, J.N., Paruelo, J.M., Somma, D.J., Buliubasich, E.C., Rodríguez, H.E., Gagnon, S., Hufty, M., 2011. Native Forests and Agriculture in Salta (Argentina). J. Environ. Dev. 20, 251–277.
Simonetti, J.A., 2011. Conservation biology in Chile: Are we fulfilling our social contract. Rev. Chil. Hist. Nat. 84, 161–170.
Špirić, J., Corbera, E., Reyes-García, V., Porter-Bolland, L., 2016. A Dominant Voice amidst Not Enough People: Analysing the Legitimacy of Mexico's REDD+ Readiness Process. Forests 7, 313.
Stamienzkin, K., Wielgus, J., Gerber, L., 2009. Management of a marine protected area for sustainability and conflict resolution: lessons from Loreto Bay National Park (Baja California Sur, Mexico). Ocean Coast Manage 52, 449–458.
Tompkins, E.L., Adger, W.N., 2003. Building resilience to climate change through adaptive management of natural resources. Tyndall Centre Working Paper No. 27, 1–19.
Toomey, A.H., 2016. What happens at the gap between knowledge and practice? Spaces of encounter and misencounter between environmental scientists and local people. Ecol. Soc. 21.
Van Der Schoor, T., Scholtens, B., 2015. Power to the people: Local community initiatives and the transition to sustainable energy. Renew. Sustain. Energy Rev. 43, 666–675.
Velázquez, A., Torres, A., Bocco, G., 2004. Las enseñanzas de San Juan: Investigación participativa para el manejo integral de recursos naturales. Gobierno del Estado de Michoacán, INE, SEMARNAT.
Vignola, R., McDaniels, T.L., Scholz, R.W., 2013. Governance structures for ecosystem-based adaptation: Using policy-network analysis to identify key organizations for bridging information across scales and policy areas. Environ. Sci. Policy 31, 71–84.
Walker, B.H., Carpenter, S.R., Rockstrom, J., Crépin, A.-S., Peterson, G.D., 2012. Drivers, "Slow" Variables, "Fast" Variables, Shocks, and Resilience. Ecol. Soc. 17.
Weichselgartner, J., Kasperson, R., 2010. Barriers in the science-policy-practice interface: toward a knowledge-action-system in global environmental change research. Global Environ. Change 20, 266–277.
Wesselink, A., Paavola, J., Fritsch, O., Renn, O., 2011. Rationales for public participation in environmental policy and governance: practitioners' perspectives. Environ. Planning 43, 2688–2704.
Wright, W.C.C., Eppink, F.V., Greenhalgh, S., 2017. Are ecosystem service studies presenting the right information for decision making? Ecosyst. Serv. 25, 128–139.