



Research

Opportunities and obstacles to socioecosystem-based environmental policy in Mexico: expert opinion at the science-policy interface

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ABSTRACT. The urgent need to revert the ecological and social equity crises of the current development model and realize the potential of sustainable development has led several disciplines to converge on the socioecosystem concept as the most appropriate theoretical framework for research and public policy. The socioecosystem approach recognizes that social systems are integrated with natural systems and seeks to adaptively manage socioecosystem coevolution for the sustainable development of both systems. We hypothesize that incorporation of this approach into environmental policy in Mexico could help resolve many of the problems that currently undermine policy effectiveness. To find out to what extent policy professionals might concur with this hypothesis, and what the opportunities and obstacles to implementing socioecosystem-based policy might be, research was conducted to elicit the expert opinion of officials responsible for formulating and implementing environmental policy in Mexico. The principle opportunities consist in the fact that experts intuitively understand the socioecosystem approach, and that most perceive advantages in adopting it because its policy attributes can potentially help to resolve many of the factors they identify as limiting the success of current environmental policies. Obstacles to its adoption include institutional barriers and the vested interests that benefit from the status quo.

Key Words: *complex adaptive systems; environmental governance; expert opinion; mainstreaming; Mexico; public policy; social-ecological systems; socioecosystem; sustainable development; transdisciplinarity*

INTRODUCTION

The current development model, based on economic growth fueled by population increase and expectations of rising material prosperity, is not sustainable economically or ecologically (Daly 2007). Nor is the inequitable distribution of the economic and ecological risks, costs, and benefits of such development sustainable socially (Raworth 2012, Moore 2015). Half of global wealth is owned by 1% of the world's population (Oxfam 2015), and 795 million people suffer from hunger and malnutrition (World Food Programme 2016). The cumulative impact of human activities on the biosphere is so intense and ubiquitous (Goudie 2013, Ellis 2015) that it is a major force in planetary dynamics (Crutzen 2002, Waters et al. 2016) and is overwhelming some of the planetary boundaries within which human societies can thrive (Rockström et al. 2009).

The long-term nonviability of this development model was attested to decades ago, spurring international agreement to promote sustainable development (United Nations 1992), defined in the *Brundtland Report* as that "...which satisfies the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:16). Sustainable development has its critics (Redclift 1987, Banerjee 2003, Escobar 2012), not least because it eludes definition in terms conducive to formulating public policy to implement it (Redclift 2002, 2006). But it remains the object of political, academic, and business discourse (Lovins et al. 2007, Spangenberg 2011, United Nations 2015), such that recent proposals for "green growth" or a "low carbon economy" are framed in sustainable development terms (Wallström 2004, OECD 2016, United Nations 2016).

Academic contributions in pursuit of sustainability have fostered the emergence of ecological economics (Costanza 1991) and sustainability science (Spangenberg 2011). They have also led to a better understanding of humanity's role in the coevolving biosphere, in the framework of complex adaptive systems (Gunderson and Holling 2002, Holland 2012), and to outlining proposals for jointly addressing the social, economic, and ecological boundaries of sustainable development (Daly 2007, Leach et al. 2012, 2013, Dedeurwaerdere 2014).

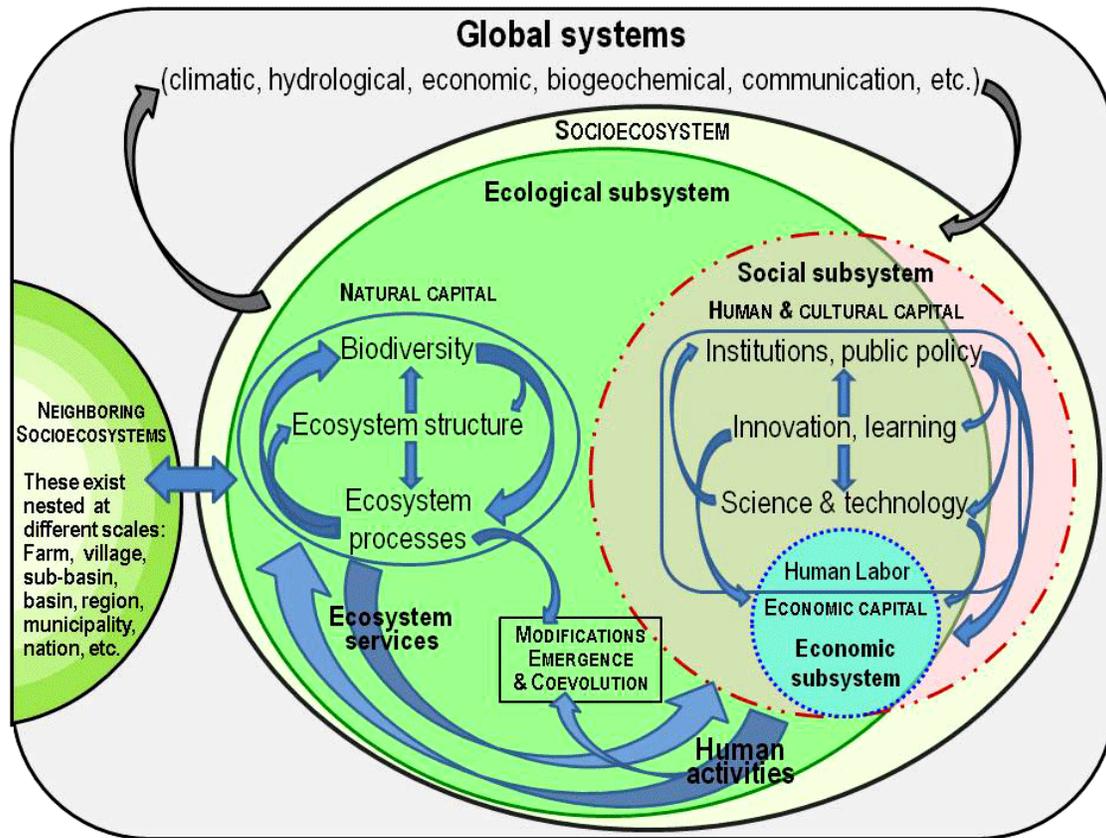
In this context, the concept of the socioecosystem is becoming increasingly relevant. Socioecosystems are conceived of as human-biological-physical entities that have emerged from ecosystems and which coevolve through integrated biophysical and cultural processes occurring across different spatial and temporal scales (Maass et al. 2016). The socioecosystem concept has been converged upon and developed by diverse branches of the biological and social sciences as an ideal framework for applied, transdisciplinary research into integrated social and natural systems, which no discipline can tackle alone, and for implementing public policy to manage them sustainably (Young et al. 2006, Ostrom 2009, Collins et al. 2011, Resilience Alliance 2018). The promise of the socioecosystem approach has fostered a proactive stance from scientists seeking to fast-track its adoption as a basis for environmental policy (Garmestani and Benson 2011, Maass 2012, Pisano 2012).

The socioecosystem, sustainability, and environmental policy

Originally conceived of by Argentine ecologist Gilberto Gallopín as a framework for implementing sustainable development, the

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Fig. 1. Schematic model of a socioecosystem: its structure, relations, and processes. Source: Compiled by the authors. Note: The economic subsystem (blue circle) is a component of the social subsystem (pink circle), with many shared elements. The social subsystem is shown partially outside of the ecological subsystem (green oval) to illustrate that some areas of social life do not directly involve the ecological subsystem. If this figure were to illustrate only the relational dependencies of the socioecosystem, it would represent the social subsystem entirely within the ecological subsystem because the people involved have irreducible biophysical dependencies (oxygenated air, food, water, etc.). Arrows indicate directions of relational influences.



socioecosystem comprises any social system integrated within any ecological system, at any one of a number of nested scales, from the local to the global (Gallopín et al. 1989, Gallopín 2001, Gunderson and Holling 2002). The concept integrates several developments in complex adaptive systems theory, including resilience, emergence, and uncertainty (Gallopín 1994, Gallopín et al. 2001, Gunderson and Holling 2002, Holland 2012). In framing the socioecosystem concept in relation to sustainable development, Gallopín emphasized its potential for avoiding processes of impoverishment of its social or ecological components as these are modified through interactions and coevolve in response to human activities (or other systemic pressures), through adaptive management (Fig. 1; Gallopín et al. 1989, 2001, Gallopín 2001, Young et al. 2006).

The socioecosystem approach to sustainable development represents an ontological rather than a methodological paradigm shift for the joint management of human activities and the environment, because it is predicated on the relational realities of its constituent elements and nested subsystems, and between

neighboring socioecosystems and systems at larger temporal and spatial scales (Maass and Equihua 2015). Humans cannot be separated from ecosystems: we evolved and are embedded within them. They constitute the matrix that makes our existence possible, on which we are wholly dependent (Maass and Equihua 2015). In turn, the economy is an emergent property of human society, embedded and dependent both upon it and the resources of the ecological subsystem (Fig. 1).

These relational realities challenge a major assumption of sustainable development as set out in the *Brundtland Report*, that of the mutual interdependence of the natural, social, and economic aspects of development (WCED 1987), often represented as a Venn diagram of three partially overlapping circles (sensu Flint 2013).

There are certainly mutual interactions, but nature per se is not dependent on people or the economy for its existence (although the survival of present species and ecosystem services is in our hands), whereas human societies and economies are ultimately dependent on nature for theirs (MEA 2005, Walker and Salt 2006,

Table 1. Policy attributes characteristic of socioecosystems and their management.

Policy attribute [†]	Description
Ecosystem approach	Based on systems theory, it permits an integrated understanding of the inter-relations between the components and subsystems comprising an ecosystem (Maass and Martínez-Yrizar 1990, Secretariat of the Convention on Biological Diversity 2004).
Integrated drainage basin approach	Water is vital for natural and social systems. It binds both together and as a resource can be managed apart. This approach means managing the basin's (sub-basin or watershed) natural and social systems to maintain the eco-hydrological processes they need to thrive, i.e., water quantity and quality indicate the health of these and their interactions (Sarukhán and Maass 1990, Maass and Cotler 2007, Wood et al. 2007, Parkes et al. 2010).
Interdisciplinary approach	Interactions between social and natural systems require inter- and transdisciplinary study to generate an integrated understanding of their functional relations (Haberl et al. 2006, Ostrom 2009, Collins et al. 2011, Maass and Equihua 2015).
Long-term vision	To construct tendencies by monitoring indicators, learn by doing, and adjust management decisions to ensure their effectiveness, the socioecosystem approach requires a multidecadal timeframe (Haberl et al. 2006, Maass et al. 2010a, Collins et al. 2011, Maass 2012).
Environmental mainstreaming	Many environmental problems stem from economic activities in the remit of different government sectors (e.g., agriculture, mining, etc.). Environmental policy integration or mainstreaming across sectors can foster less harmful activities (Dresner 2002, Lafferty and Hovden 2003, Freudenburg 2005, IIED 2007, Wood et al. 2007).
Public-private financing	The collaborative, interdisciplinary, multistakeholder and long-term nature of socioecosystem research and management for sustainable development is an investment for all. Public-private financing allows the costs of the investment to be shared among stakeholders (Grimsey and Lewis 2004, Garmestani et al. 2008, Collins et al. 2011).
Stakeholder participation	Fully representative participation of stakeholders is integral to socioecosystem management. It ensures that scientific and nonscientific, user-relevant expertise contributes to decision making and fosters transparency, accountability, and a more democratic process (Funtowicz and Ravetz 1991, Maasen and Lieven 2006, Jordan 2008, Callon et al. 2009).
Effective communication and dissemination	Collaboration between scientists from different disciplines (inter- and transdisciplinarity), government officials from different sectors (mainstreaming), and stakeholders with relevant expertise requires appropriate mechanisms (fora, workshops, networks) and skilled communicators, to synthesize, share, and make knowledge accessible to all (Castillo 2000, Callon et al. 2009, Ostrom 2009, Maass and Equihua 2015).
Effective (environmental) governance	Policy implementation needs coordinated stakeholder action across spatial and temporal scales, via a polycentric (nested) arrangement of government tiers, research institutions, producer organizations, etc., effective legal frameworks, and institutional arrangements (Olsson et al. 2004, Jordan 2008, Brondizio et al. 2009, Young 2010).
Sustainability indicators	These are required for research, diagnosis, policy formulation, and results monitoring. Appropriate indicators (not existing ones, regardless of value) are indispensable to detect changes in socioecosystem variables (Stanford and Poole 1996, Valentin and Spangenberg 2000, Neumayer 2010, Collins et al. 2011, Maass 2012, United Nations 2015).
Monitoring and evaluation	Monitoring of sustainability indicators detects changes in system variables. Knowing the scale, rate, and tendency of change allows evaluation of management decisions and their results. Monitoring is not the exclusive preserve of scientists: participatory monitoring and citizen science have important roles to play (Stanford and Poole 1996, Berkes and Folke 1998, Astier et al. 2008, 2012, Collins et al. 2011, Maass and Equihua 2015).
Adaptive comanagement	Adaptive (co) management (<i>sensu</i> Holling 1978) helps to cope with uncertainty in socioecosystem management by responding to changes in state conditions (monitored via indicators) with adaptive changes in management, either to return the direction of socioecosystem evolution to a chosen course or to opt for a new course consistent with the new conditions. Institutions within the governance structures involved in socioecosystem management must be flexible enough to respond to change and learn from experience (Holling 1978, Berkes and Folke 1998, Yorke et al. 2002, Olsson et al. 2004, Armitage et al. 2009, Ostrom 2009, Collins et al. 2011).

[†] This shortlist is a key component of the conceptual framework used to elicit expert opinion. It derives from a literature review focused on socioecosystem management for research and public policy. These policy attributes were selected on the basis of their frequent occurrence (in some form) in the publications consulted, together with their conceptual compatibility. For example, sustainability indicators, monitoring and evaluation, and adaptive management often occur together. Environmental mainstreaming, stakeholder participation, communication and dissemination, and effective environmental governance can also occur together, but not always. Some of these policy attributes occur only partially developed (e.g., degrees of stakeholder participation), singly, or as subsets in some publications (as in some existing policies). Because of this, although partial conceptual overlap exists between some of them, listing all 12 avoids assumptions as to degrees of inclusivity or exclusivity between them. There is no a priori rationale behind the policy attributes, nor has one been imposed *ex post* to shoehorn them into pre-existing schema within the field of socioecosystem research. Although this list is not in any particular order or intended to be exhaustive, we consider that all 12 policy attributes, taken together, can be considered characteristic of a socioecosystem approach to public policy. None of them could be omitted without leaving some integral aspect of socioecosystem management unattended, and most additional attributes would tend to be more context specific.

Maass and Equihua 2015). This is central to the argument of ecological economics for pursuing strong rather than weak sustainability (Gómez-Baggethun and de Groot 2007, Döring and Muraca 2011). Strong sustainability recognizes that natural capital (biodiversity, ecosystem services, and natural resources) cannot be transformed into and substituted for *ad infinitum* by human or economic capital, as the weak sustainability of neoclassical economists suggests, because its life-supporting

functions mean that its true value for living beings transcends its economic value (Costanza and Daly 1992, de Groot et al. 2003, Ekins et al. 2003). Natural capital and human or economic capital are, in fact, complementary (Daly 2007). The current ecological and social crises suggest that the neoclassical weak sustainability adopted as policy by default is tantamount to unsustainability (Dedeurwaerdere 2014). Without changes to prevailing economic theory and policy, a socioecosystem approach to environmental policy is unlikely to foster sustainable development *per se*, but its

implementation could make policy outcomes more successful and sustainable through more informed, transparent, and flexible decision making.

Conventional policy frameworks tend to treat people as separate from nature, and government as separate from both (Chandler 2014); but government clearly does not exist in a separate reality, although it can sometimes feel like it. This artificial conception of government as unentangled in the networks of actors, actions, and consequences that comprise reality can compound imbalances in power relations that benefit some actors while harming others. This is not conducive to desired policy outcomes and can impede learning from real-world experience (Sterman 2006, Chandler 2014, Moore 2015).

The ontological basis of the socioecosystem approach to policy better reflects our evolving understanding of reality as comprising actors (human and nonhuman) embedded in networks of relational linkages, such that the direct or indirect consequences of our actions can affect each other's welfare and contribute to either eroding or regenerating natural capital (Maass and Equihua 2015). These reciprocal interactions produce emergent properties that cause the whole to coevolve, so better informed choices should produce more desirable outcomes (Sterman 2006, Chandler 2014, Maass and Equihua 2015).

Based on a literature review focused on socioecosystem management for research and public policy (which included the search terms: socio-ecological system, social-ecological system, SES, sistema socio-ecológico, socioecosystem, and socioecosistema), we have identified a diverse set of concepts, criteria, and approaches referred to repeatedly in the publications consulted (with different emphases, depending on context and author), which we call policy attributes (Challenger et al. 2014), that together may be considered characteristic of the socioecosystem approach (Table 1).

Given the nature of the socioecosystem (Fig. 1), these policy attributes provide a practical operational framework for applied research and for formulating and implementing policy initiatives for the sustainable management of integrated social and natural systems (Maass and Equihua 2015). In particular, they should foster a more inclusive, transparent decision-making process, allowing a more flexible response to the emergent behavior of the coevolving socioecosystem, while learning by doing (Walker and Salt 2006, Chandler 2014, Fischer et al. 2015, Maass and Equihua 2015).

Our working hypothesis is that the incorporation into environmental policy of those policy attributes conducive to the sustainable management of socioecosystems can create opportunities to improve policy outcomes by addressing the obstacles that currently undermine policy effectiveness in Mexico, i.e., institutional barriers, limited public participation, and other problems of implementation.

Our aim is not to test this hypothesis directly, but to find out to what extent policy professionals concur with it, and what the opportunities and obstacles to implementing socioecosystem-based policy might be. To that end, we conducted research to elicit the expert opinion of government officials on the potential advantages or disadvantages of the socioecosystem approach relative to current approaches to formulating and implementing environmental policy in Mexico.

Integrating the socioecosystem approach into public policy: Mexico as a case study

Except when it serves some military, economic, or emergent public health interest, the movement of ideas across the science-policy interface is slow (Hoppe 2005). Tansley's ecosystem concept (1935), central to ecology since the 1930s, was not integrated into policy for decades: 1970 in the USA and 1982 in Mexico (U.S. Congress 1970, SEGOB 1982). This presents an obstacle to the relevance of science and to the relevance of public policy, to the detriment of both, and must be addressed proactively by scientists and policymakers.

Although the socioecosystem concept has been converged on by diverse scientific fields and is included in the agendas of some conservation and development organizations (Ravera 2005, Viota Fernández and Maraña Saavedra 2010, Fischer et al. 2015), it barely figures in policy documents (Garmestani and Benson 2011, MADS 2012, Pisano 2012, Galán et al. 2013; see also <http://www.sd-network.eu/>), and no socioecosystem-based public policies have yet been implemented anywhere (Challenger et al. 2014).

In Mexico, as elsewhere, political and conceptual tensions exist between the environment sector and other sectors (e.g., agriculture, mining) and tiers of government (e.g., some state governments subsidize livestock production in federal protected areas), and even between agencies within the sector, hampering effective policy implementation (Leff 2002, Domínguez 2002). Nevertheless, environmental policy has evolved, influenced by international developments, from a narrow focus on resources in the 1980s, e.g., fish, lumber (SEGOB 1983a), to a more integrated, ecosystem-based management today, e.g., sustainable fisheries and forest management, environmental impact assessment, etc. (SEGOB 1996, 2007). However the ecosystem approach, as defined by the Secretariat of the Convention on Biological Diversity (2004), to which Mexico is party, has not been written into law or policy (Challenger et al. 2014; see also http://docplayer.es/46112580-Que-entendemos-por-enfoque-ecosistemico.html#download_tab_content). The policy attributes we identified as characteristic of the socioecosystem approach could help to alleviate these conceptual tensions and omissions, while also addressing other factors limiting policy success.

The perceived advantages of the socioecosystem approach have led to a concerted effort by academics in Mexico to raise its profile, spearheaded by the Mexican Long Term Ecological Research Network (Maass et al. 2008, 2010a), supported by the government's National Commission for the Knowledge and Use of Biodiversity (CONABIO). This includes a chapter proposing socioecosystem-based environmental policy in a key 2012 book on Mexico's development (Maass 2012), the same year in which the socioecosystem concept was first mentioned in a policy document on climate change adaptation (INECC-SEMARNAT 2012). There followed a book coedited by CONABIO and the Ecosystems Research Centre of the National Autonomous University of Mexico (UNAM; Galán et al. 2013), Mexico's first symposium on socioecosystem management (Martínez Ramos 2014), and a related monograph (INECC 2014). Besides contributing to research, such initiatives help build consensus in academic and government circles for the adoption of socioecosystem-based public policy (Castellarini et al. 2014).

We explored the receptiveness (or otherwise) of government officials to the socioecosystem concept as a basis for policy.

Fieldwork was conducted to gain an insight into the expert opinion of those directly involved in formulating and implementing environmental policy in Mexico. Given that no public policies for managing socioecosystems have been implemented anywhere to date (Challenger et al. 2014), and in Mexico, as elsewhere, the socioecosystem concept is unlikely to be familiar to government officials, it is not possible to ask directly. It was thus decided to elicit their opinions based on a brief definition of the socioecosystem concept and a description of what the socioecosystem approach might bring to public policy. This was done after indirectly obtaining their opinions on those policy attributes characteristic of the socioecosystem approach (Table 1), some of which are, to a degree, integral (individually or as subsets) to the policies for which the experts are responsible (Challenger et al. 2014). Further enquiry was made into the factors or contexts that facilitate or obstruct deployment of these policy attributes in the process of policy formulation and implementation, and their effects on policy outcomes.

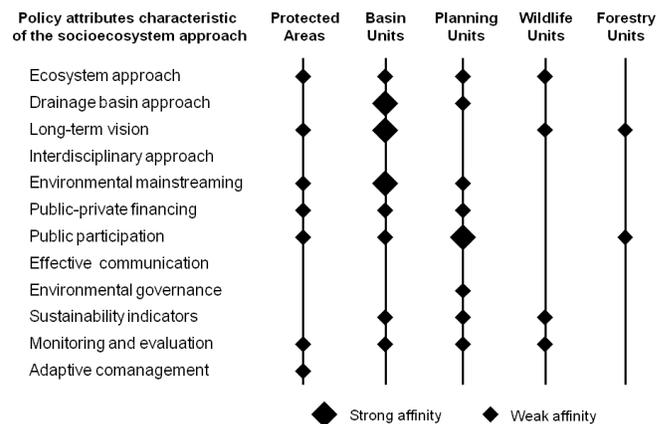
METHODS

The areas of expertise of the consulted officials took into account a previous study to determine which of Mexico's federal environmental management policies have the most affinity with the socioecosystem approach. The study examined five policies, each having a territorial management function, as with any future socioecosystem-based policy, their spatial definition based on ecological criteria, established in law (Challenger et al. 2014). These policies are similar to those with comparable aims in other countries (Fig. 2):

1. Protected natural areas (hereafter, protected areas): Administered by a national commission (CONANP), they include national parks, biosphere reserves, etc., in which well-conserved ecosystems predominate. The state is not a significant landowner in Mexico, and most protected areas are established on nonstate land and comanaged by local communities and CONANP personnel, according to a management plan.
2. Drainage basin management (hereafter, basin units): Administered by the National Water Commission (CONAGUA), via drainage basin commissions and councils, the director of which is usually a CONAGUA official, other members representing major water users (e.g., municipal governments, farmers, industry) and civil society (NGOs, etc.). Basin units have the most affinity with a socioecosystem approach (Fig. 2).
3. Environmental management units (planning units): The basis for ecological land-use planning (landscape-level land-use planning) and administered by the Ministry of the Environment (SEMARNAT), they have the second highest affinity with the socioecosystem approach.
4. Management units for wildlife conservation (wildlife units): Administered by SEMARNAT, these are voluntarily established in natural habitat on private or common property and administered to conserve or sustainably manage selected species (for hunting, ecotourism, trade, etc.) following a SEMARNAT-approved management plan.
5. Forest management units (forestry units): Administered by the National Forestry Commission (CONAFOR), in

partnership with regional forestry associations whose members undertake forest management according to SEMARNAT-approved management plans. They have the least affinity with the socioecosystem approach (Fig. 2).

Fig. 2. Affinity of selected environmental policies with the socioecosystem approach. Source: Modified from Challenger et al. 2014:10.



To build on this precedent, 20 experts were selected from among current or recently retired government officials responsible for formulating or implementing these five policies, four from each. Results are mediated by the fact that each is an expert primarily in her or his own policy, which could imply that their responses are somewhat value laden regarding the reputations of these, although an insignificant net bias is assumed. Even so, we performed an exploratory analysis of the coded expert response data to evaluate any possible influence relating to the experts' characteristics or the institutions they represent. Using R, we applied agglomerative hierarchical clustering, principal component analysis (PCA, summarized in Biplot graphs), and a classification tree (R Core Team 2017).

Stratified purposeful sampling was used to select individuals with highly relevant professional experience as information-rich cases (Patton 2002; Appendix 1 gives a brief profile of the experts). Each was asked to answer a questionnaire before responding to questions during a semistructured interview. Both sets of questions involved consulting the experts with regard to the 12 policy attributes encapsulating core concepts of the socioecosystem approach, described in Table 1. Appendix 2 gives the rationale for these surveys, and Appendix 3 lists the interview questions. An additional 10 experts with a more academic profile and having held more senior government posts (see again Appendix 1) were sent identical questionnaires (without being interviewed) to triangulate the responses of the previous 20. The 30 experts represent a good sampling intensity of the small population of key, experienced people available in Mexico. Once all the interviews were completed (April to August of 2014), two methodologies were used to analyze the data:

1. Inductive qualitative analysis of the experts' responses, in accordance with grounded theory, the "discovery of theory from data" (Glaser and Strauss 2012:1). The interview transcripts were uploaded to the software Atlas-ti and the text was reviewed and coded (an iterative process) to reveal the major themes, issues raised, and where opinions coincide or differ between policy subgroups (Patton 2002). The codes and memos synthesizing the interview data were interpreted to identify the linkages between the concepts and issues they represent. Related codes and memos were grouped into more inclusive and complex categories that link together conceptually. These were grouped into a second, still more inclusive set of categories to permit an explanatory theoretical framework to emerge, grounded in the data and communicable as a narrative (Patton 2002, Hernández Sampieri et al. 2006, Glaser and Strauss 2012).
2. Ranking analysis of the numerical data generated from the questionnaires. This reveals the order in which experts ranked, collectively and by subgroup, the policy attributes in terms of their relative importance for effective public policy. This was done last, to avoid influencing the results of the qualitative analysis.

Besides these analyses and the results reported here, a deductive qualitative analysis of the interview transcripts and a ranking analysis of a second exercise from the questionnaire were also undertaken. Presenting all the results in a single article implied losing valuable information, so it was decided to divide them between two articles; one in Spanish for the Mexican and Latin American audience, including the results of the deductive qualitative analysis and the second ranking analysis (Challenger et al. 2018), and this article intended for an international audience.

RESULTS

Cluster analyses

In seeking to evaluate the possible influence of experts' characteristics or the institutions they represent on expert response data, both clustering and PCA analyses showed no clearly identifiable allocation pattern based on gender, education level, or professional background.

Inductive qualitative analysis

The category system grounded in codes and memos is a good fit to the data (Appendix 4), yielding the conceptual framework for the following narrative, based on second level categories. Figure 3 shows the top 46 (out of a total of 84 listed in Appendix 4) of those concepts or factors (codes) mentioned in the text, ranked by relevance according to the number of experts raising them in response to interview questions. The affirmations in the text are based on the opinions expressed by a majority of the experts, except where otherwise stated. Quoted responses have all been translated from Spanish.

The national and international political and economic context

Most experts consider vested interests and insertion in the global economy as the root of many of Mexico's environmental and social problems. One claimed Mexico's development model has "...produced a country in territorial, environmental and social disequilibrium." Economic, political, social, or criminal vested interests often express opposition to environmental policies, and

conflicts can arise when development projects by capital investors and government are perceived as threatening the local environment, property, resource use rights, or culture (sensu Escobar 2012), experts explained. Examples include tourist development in the Chamela-Cuixmala Biosphere Reserve, the Cabo Pulmo and Nevado de Toluca national parks (Pesenti and Dean 2003, Castillo et al. 2009, Ceballos 2011, Johnson 2013, World Post 2014; also see <http://redaccion.nexos.com.mx/?p=5738>).

A contributing factor is the difficulty of demonstrating the economic value of conserved natural capital in situ. This undermines the environment sector's leverage, because, as one expert stated, "we don't have the political capital to enable us to have a dialogue of equals with other sectors..." or with society at large, because economic values are used to judge the merits of competing claims to political priorities. Hence the environment sector is given a low budget, and agricultural subsidies are far more generous than those for forestry units or wildlife units, even while causing environmental degradation.

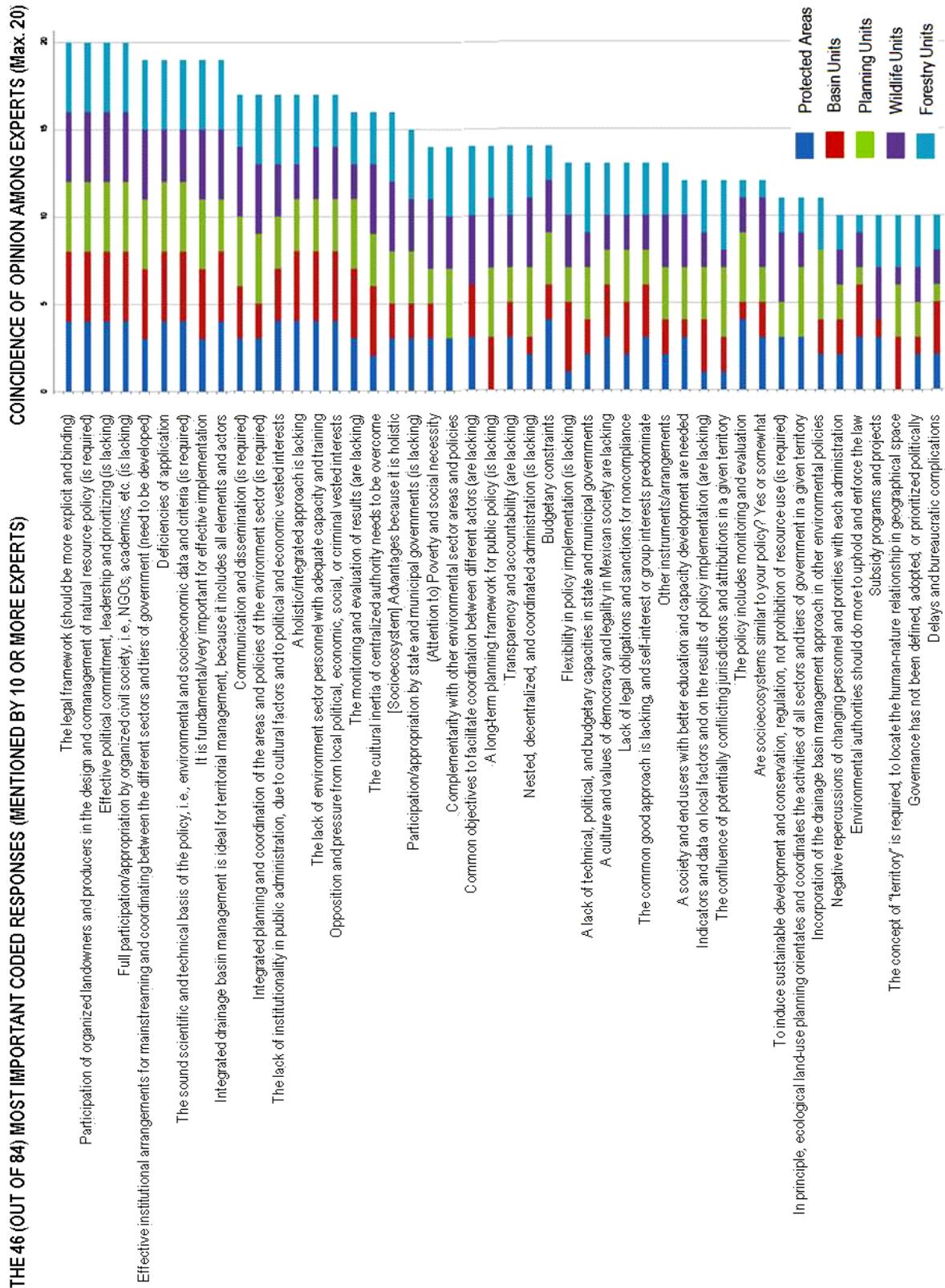
Civil society's response to development projects perceived as posing environmental or social risks has been to leverage international pressure on Mexico's government. Experts noted, "...when society has raised its voice to international levels [...] incongruent decisions have been stopped," and, "...the environment is now an international obligation, which the country must comply with." But Mexico's intransigent political and socioeconomic elites resist environmental policies, and even the longer-term planning horizon government officials aspire to, for the sake of greater policy effectiveness (see Appendix 4). One expert explained, "...it's a kind of taboo. [...] You can mention it, but you can't put it in writing [...], it could be taken as a rebellion [...] against the status quo."

Strengths and weaknesses of the legal framework

Most interviewees referred positively to the existence of laws underpinning the policies for which they are responsible. The strength of the presidential decree was emphasized in relation to protected areas, founded by decrees that transcend administrations and are mandatory across sectors and tiers of government. Also, regulating resource use is preferred to prohibition, which, with important exceptions, is considered counterproductive; so recent changes to Mexico's federal statute regulating the management of wild species, the General Law on Wildlife, to prohibit the capture of endangered parrots (SEGOB 2008), is regarded as retrograde.

Effective implementation of policy is hampered, however, by a legal framework lacking in detail with dispositions that are nonbinding or without sanctions, thus also hindering enforcement. In relation to planning units, one expert observed, "...neither the law nor its regulation are clear on how it should be applied. [...] there is no mechanism, as such, to say that you are complying or not, [...] there are no sanctions, no responsible agencies, all of which are legal and administrative vacuums." The intersectoral coordination outlined in national development plans and the intertier subsidiarity (*conurrencia*) set out in the constitution (SEGOB 1983b, 1987a, b) are also problematic in practice, each sector and tier having its own objectives and legal framework, or lacking one, as do many municipalities (Mumme 2007). As a result, the confluence of conflicting jurisdictions in a

Fig. 3. Coincidence of expert opinion (subdivided by policy) illustrates the relative importance of each concept (the top 46 of 84 response codes) to successful policy implementation. Source: Compiled by the authors based on the coded data from interview transcripts, generated using the software Atlas-ti.



given territory hinders policy implementation. For example, SEMARNAT's ecological land-use planning (based on planning units) can clash with the territorial planning of local governments, sanctioned by the Ministry of Agrarian, Territorial and Urban Development (SEGOB 1993, 2003, SEDATU 2013). Conflicts between government sectors and tiers can even reach the Mexican Supreme Court (Mumme 2007, SEGOB 2011).

Some experts noted that restrictions on allocating subsidies (e.g., for forest management) and federal programs mandating multisector support, irrespective of sectoral priorities, can impede effective targeting of priority areas. Recently, for example, the Ministry for Social Development's "National Crusade against Hunger," compelled every agency controlling subsidies to channel some support to municipalities with extreme food poverty (Robles Berlanga 2014). Experts also believe the "antiquated" federal Planning Law's single administration (six year) timeframe obviates strategic planning (SEGOB 1983b).

Strengths and weaknesses of the technical basis of policy

Experts affirm that policy should be based on sound scientific and technical criteria. Although most consider this aspect a strength of their policy, some signal deficiencies, notably for forestry units. Several remarked that the different spatial approaches employed, either as technical criteria (ecosystem, drainage basin, planning unit) or legal definitions (private property, drainage basins, forestry units, etc.), make some policies mutually incompatible. One noted: "This is chaos [...] what you have to reorganize on the basis of drainage basins is the whole sector."

The need for a more integrated approach to environmental policy is widely recognized; some experts emphasizing greater interdisciplinarity, others the inclusion of nonscientific expertise (e.g., from local or indigenous communities). Systematic data collection for policy-relevant variables is also lacking, impeding robust diagnoses, monitoring, and the evaluation of policy results. Monitoring and evaluation for adaptive management, considered by experts fundamental to policy success, is integral to all policies but rarely occurs in practice. This is compounded by legal constraints on modifying management plans (e.g., forestry) and time consuming processes such as consensus building among stakeholders (e.g., in protected areas) or obtaining permissions from regulatory authorities, thereby reducing policy flexibility.

Water quality is an indicator for which some data exists or can be readily generated and is key to drainage basin management (Maass 2004). All but one expert considered the integrated drainage basin approach ideal for territorial management, by including all elements and stakeholders. Most even considered its incorporation into their own policies both possible and potentially advantageous (e.g., for planning units; Fig. 3; Appendix 4). But drainage basin management in Mexico is hampered by deficient implementation. As defined by the National Water Commission (CONAGUA), drainage basins are considered too large by some experts, sub-basins or local watersheds (*microcuencas*, having no legal status) regarded as more practical. Also, CONAGUA manages water resources almost independently of the ecological factors involved in water availability in basins (Appendix 4). One expert claimed this approach merely reflects Mexico's federal statute on water management, the Law of National Waters (SEGOB 1992), others

noting that a true policy for integrated drainage basin management doesn't exist in Mexico.

Strengths and weaknesses of institutional arrangements

Mexico's environment sector has become an unwieldy assemblage of semiautonomous agencies since its reconfiguration in 2000 (SEMARNAT 2006). Repeated references were made to the lack of integrated planning and coordination between different areas and policies, which reduce the sector's effectiveness. Some experts mooted organizational and institutional redesign, and one remarked: "...if we [...] don't talk to each other, then how can we expect the Agriculture Ministry to consult with us about its agricultural policy, not to mention on fisheries...?" A lack of effective communication and dissemination is deemed a contributing factor, hampering both clear leadership and a properly informed staff and public (wildlife unit experts express particular frustration at this).

Decentralized agencies with large budgets, like CONAGUA, the National Forestry Commission (CONAFOR), and even the Attorney General for the Environment (PROFEPA), are regarded as too autonomous, and some of their policies are seen as counterproductive. In contrast, the National Commission for Protected Natural Areas' (CONANP) mandate has been expanded excessively: one expert noted that by charging protected areas with biodiversity conservation, maintaining ecosystem services, and mitigating and adapting to climate change, "...we are asking too much." Others expressed the complementary view that ecological functionality and biodiversity must be conserved outside protected areas via other environmental policies and more ecologically sensitive policies from other sectors, particularly agriculture.

Most experts voiced frustration at the disparity between the intentions of centralized policy as formulated and its results on the ground, noting a lack of nested, decentralized agencies for coordinating policy instrumentation at the local level. The decentralization of wildlife policy (via wildlife units) to six state governments was successful only after the required political, technical, and budgetary capacities were developed locally.

Many experts acknowledged that coordinated implementation at the local level can be facilitated by having a presence in situ (Appendix 4), some citing protected areas and CONABIO's Biological Corridors Program as examples, but most policies lack the field staff and regional offices required. Indeed, the lack of effective institutional arrangements for coordinating between the different sectors and tiers of government was cited as an impediment to the successful implementation of policies by 19 of the 20 experts.

Factors and policies that facilitate mainstreaming and coordinated implementation between the sectors and tiers of government

In the absence of effective institutional arrangements, facilitating the mainstreaming and coordinated implementation of policies requires other means. Most experts consider having shared objectives or complementary policies (including with other sectors, like agriculture) helps to achieve this. These can be catalyzed by a third factor, subsidized support programs, which although limited, are available for protected areas, wildlife units, and forestry units. Success occurs particularly when local communities can diversify economically, experts citing, for

example, livestock farming coexisting with wildlife units in different areas of some ranches, and wildlife units in protected areas.

Government programs of prevention and response to natural disasters can also galvanize mainstreaming and coordinated policy implementation. As one expert said: "... there's no water in the Cutzamala [water supply] system? Then the tiers [and agencies] of government...start talking to each other." Indeed, water itself is regarded as a crosscutting issue, fostering coordinated policy implementation between government sectors and tiers. Some experts tacitly acknowledged that subsidies and natural disaster prevention and response are de facto investments in natural and human capital, including the institutions of local governance, which can improve coordinated policy implementation indirectly.

Most experts noted that planning unit based ecological land-use planning was conceived to facilitate coordinated policy implementation between government sectors and tiers to foster ecologically compatible land uses, but has had limited success. Some mentioned protected areas as having done a better job, depending on the abilities of their directors and field staff.

Stakeholder participation and capacity building are needed at all levels

Experts unanimously regarded public participation (by landowners, producers, academics, NGOs, etc.) in policy formulation and implementation as key to their success. Participation by state and municipal governments is also regarded as important. One expert remarked: "For the process to be legitimate, all sectors should be represented, in a way that is organized and that truly reflects the interests of the actors..." Others noted that producers and social actors need to be better organized, and a majority considered that better education and more capacity building would enable them to participate more effectively.

Insufficient capacity building was considered by most experts to affect all actors, including environment sector personnel (reflected even in expert responses, as some misunderstood governance or adaptive management). For example, the field technicians responsible for forestry or wildlife management plans are considered largely unreliable and self interested, while the poor technical, political, and budgetary capacities of state and municipal governments hamper coordinated, decentralized policy implementation.

The strength of environmental policy depends more on the personal convictions of political leaders than on institutional strength

Experts unanimously lamented the lack of political commitment, leadership, and prioritizing with regard to environmental policy, this being one of the three most frequently cited issues (Fig. 3, Appendix 4). Its manifestations include the changing of personnel and priorities with each administration, thereby losing institutional memory and opportunities for institutional learning (sensu Carpenter et al. 2002). The current administration (2012-2018) is perceived as presiding over more backtracking than advances. Some experts perceive weak leadership from the Environment Secretary; others believe the strength of environmental policy rests ultimately with the president. A president disinterested in environmental issues undermines the

sector's political power, and the scope and impact of policy. One expert recalled the importance of climate change to President Calderón, his administration (2006-2012) was responsible for mainstreaming climate change policy, including the publication of a General Law on Climate Change (CICC 2009, SEGOB 2012). This expert also affirmed that the concept of governance, also high on the agenda then, has now almost vanished from official documents, and some experts consider it a "political fad."

Commitment and leadership are also required from each agency within the sector; most experts affirming authorities should do more to uphold and enforce environmental laws. One remarked: "...any kind of [organization], for it to function properly, must assert its authority, because if [organizations] don't assert their authority, then you're left with the law of the jungle."

A crisis of governance exists in Mexico

Lax enforcement of environmental law and policy is symptomatic of a pervading lack of institutionality in public administration in Mexico (including corruption, clientelism, ineptitude, and authoritarianism), which experts variously ascribe to cultural factors, and political and economic vested interests. The National Water Commission (CONAGUA) is repeatedly criticized for its excessive autonomy and poor record on ensuring compliance with the law. One expert affirms: "CONAGUA sees illegal acts, but doesn't sanction them. I think more than 70% of irregularities go unsanctioned".

All forms of noninstitutional behavior are considered counterproductive by experts for their impact on policy effectiveness and public trust. Most affirm the need for greater transparency and accountability, the lack of which erodes the credibility of authorities. This exacerbates the low levels of interpersonal trust pervading Mexican society (OECD 2011), itself a barrier to public participation in the policy process. Together with a poorly developed culture of democracy and legality, and the predominance of self-interest over the common good (partly related to Mexico's intractable poverty, insecurity, and criminality) most experts believe a crisis of values permeates Mexican society.

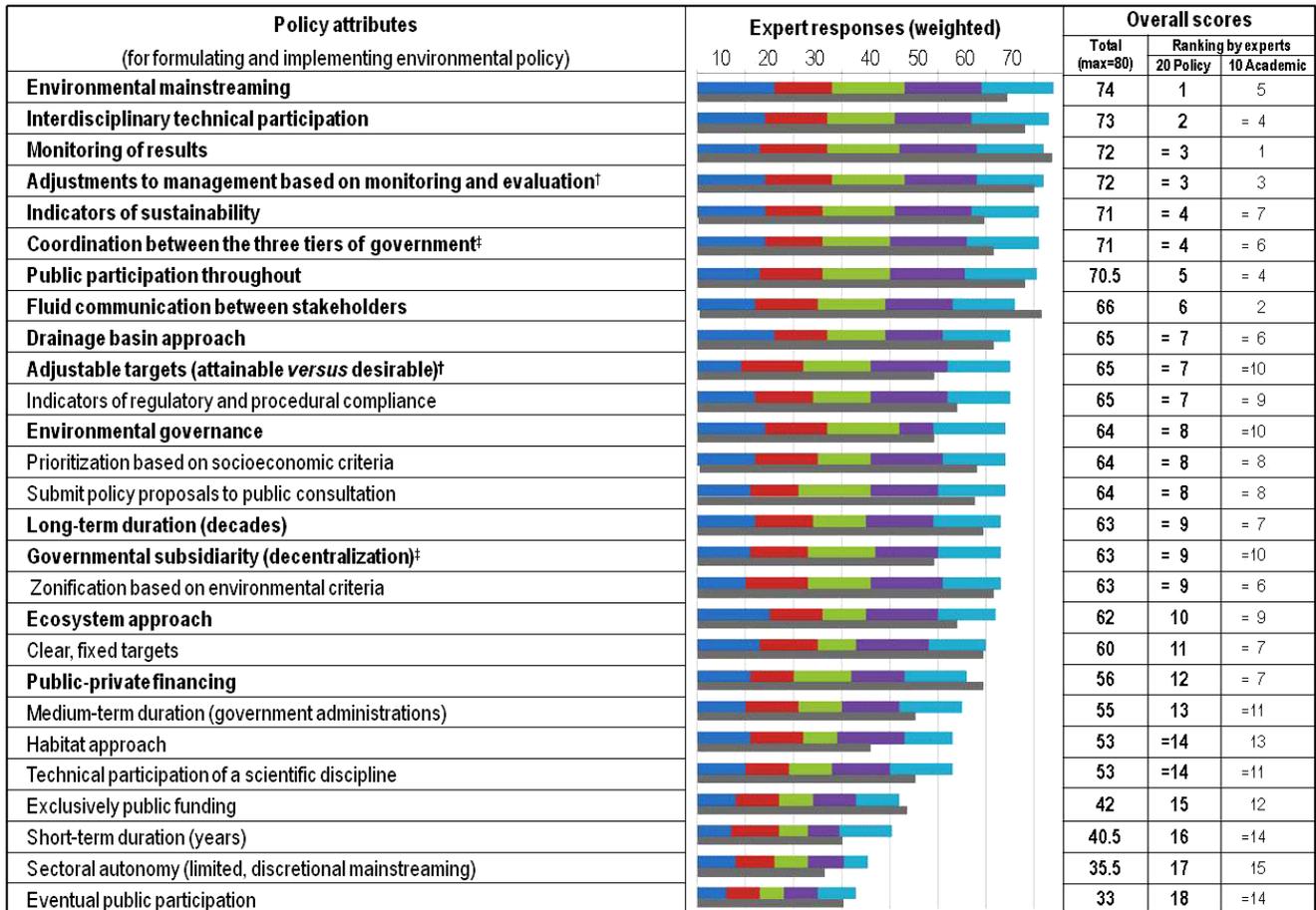
Organized crime also affects environmental policy. When faced with well-armed narcos, i.e., thugs employed to protect drug cultivation and processing, one expert remarked: "with a pencil and paper, PROFEPA [the Attorney General for the Environment] is going to do absolutely nothing in defence of protected areas." Corporate interests and investment capital also bring pressure to bear; some experts reporting that proponents of development projects (private and public) attempt to influence or undermine policy, mostly in relation to environmental impact assessments.

All of these failings undermine environmental governance, which most experts consider fundamental to policy success, while acknowledging it has yet to be defined, adopted, or prioritized politically. However, some affirm that policies such as protected areas, basin units, and wildlife units, simultaneously rely on and promote governance, through public participation and by identifying shared policy objectives.

Deficient application of environmental policies limits their success

While asking experts about the relative strengths and weaknesses of different policy attributes, and the factors and contexts

Fig. 4. Expert rankings of socioecosystem versus nonsocioecosystem policy attributes. Source: Compiled by the authors, based on the weighted results of the questionnaires returned by the experts. Note: Bars representing the 10 academic experts' rankings were doubled in length to aid comparison with the 20 policy experts.



Key: Policy attributes in bold = Socioecosystem Protected Areas Basin Units Planning Units Wildlife Units Forestry Units Academic Experts

† = Component attributes of adaptive comanagement ‡ = Component attributes of the multiscalar aspect of environmental governance

influencing the formulation and implementation of policies, responses citing obstacles to policy success outnumbered by 2:1 factors conducive to success. Most experts acknowledged shortcomings, technical, legal, etc., in the policies for which they are responsible, but 19 of the 20 cited deficiencies of application as the major obstacle to success.

Advantages are perceived in the integrality of the socioecosystem approach

Regarding the socioecosystem concept, most experts have an intuitive grasp of it even though only two had prior knowledge of it. Having listened to a working definition of the socioecosystem concept and a description of what the socioecosystem approach might bring to environmental policy, most experts representing all policies considered that theirs shared similarities with it (some expressed doubts, six perceived no similarities).

Most experts, representing all policies, perceived advantages in adopting the socioecosystem approach as a basis for

environmental policy, given its holistic, integral nature, with its potential to make policy more relevant to stakeholders. Some considered its interdisciplinary focus would ensure a strong technical and scientific base. A few doubted whether, in practice, it would achieve its potential, motivate sufficient stakeholder participation, or prove compatible with the policies of the Ministry for Social Development. Two experts mentioned that the socioecosystem approach is currently being discussed within the sector, in relation to policy.

Ranking analysis

Most of the 12 socioecosystem policy attributes, subdivided into 15 for this exercise, were rated above nonsocioecosystem attributes. The top 10 were all socioecosystem policy attributes, the bottom 7 were all nonsocioecosystem attributes, with 5 of each sharing midranking. In Figure 4, these results are presented together with the results of the 10 academic experts, to triangulate the former. These show a broadly similar distribution (although most attributes were scored slightly lower), with some interesting deviations, including lower scores for the socioecosystem

attributes of adjustable targets and environmental governance, and higher ones for the socioecosystem attributes of fluid communication and public-private funding.

DISCUSSION

The results of both survey analyses demonstrated that in the opinion of the government experts consulted, almost all those policy attributes characteristic of a socioecosystem approach are considered integral to achieving successful policy outcomes. By extension, the numerous obstacles to successful policy outcomes identified by the experts (technical, legal and institutional flaws, cultural and contextual factors, etc.), could hypothetically be addressed, at least in part, by deploying the socioecosystem approach and its policy attributes, which are underdeveloped in, or absent from, current approaches. The following statements synthesize the situation described by the experts (socioecosystem attributes in quotation marks):

- Limited “interdisciplinary collaboration” undermines the technical and legal basis of policy;
- Limited “stakeholder participation” undermines policy consensus and outcomes;
- In turn, inadequate legal frameworks and institutional arrangements hinder “environmental mainstreaming” and polycentric “environmental governance;”
- A productivist, resource-based approach to implementing “drainage basin management” frustrates the integrated premise of its theoretical basis;
- Limited data availability impedes the systematic use of “sustainability indicators;”
- This and other obstacles to “monitoring and evaluation” frustrate “adaptive (co-) management;”
- Ineffective “communication and dissemination” of information hinders policy success;
- The absence of a “long-term vision” makes strategic planning and policy impossible;
- The lack of institutionality, trust, democratic values, and respect for the rule of law undermines “environmental governance.”

The only socioecosystem policy attributes to receive scant attention and modest ranking from experts are the ecosystem approach and public-private financing (Fig. 4). Perhaps the former is considered only moderately important. Or, as many policies incorporate the ecosystem concept (Challenger et al. 2014) if not the ecosystem approach per se, some experts may conflate the two, taking the ecosystem approach for granted. In contrast, public-private financing has limited traction in Mexico’s environmental policy beyond improving municipal waste and water treatment (World Finance 2013; see also <http://www.fonadin.gob.mx/>).

The issues raised by the experts regarding the legal, institutional, cultural, and political factors constituting opportunities or obstacles to successful environmental policy in Mexico, are well documented (Eakin and Lemos 2006, Mumme 2007, Challenger and Dirzo 2009, Cotler and Caire 2009, Monsiváis Carrillo 2009, Williams 2009, Castañeda 2011, Hurtado 2011, OECD 2013). So

too are the national and international contexts (Costanza et al. 1998, Keck and Sikkink 1998, Gallagher and Zarsky 2007, Laurila-Pant et al. 2015). Similar factors and contexts affect most nations, differing more by degree than by type (Liverman and Vilas 2006, Brondizio et al. 2009, Edmonds 2011).

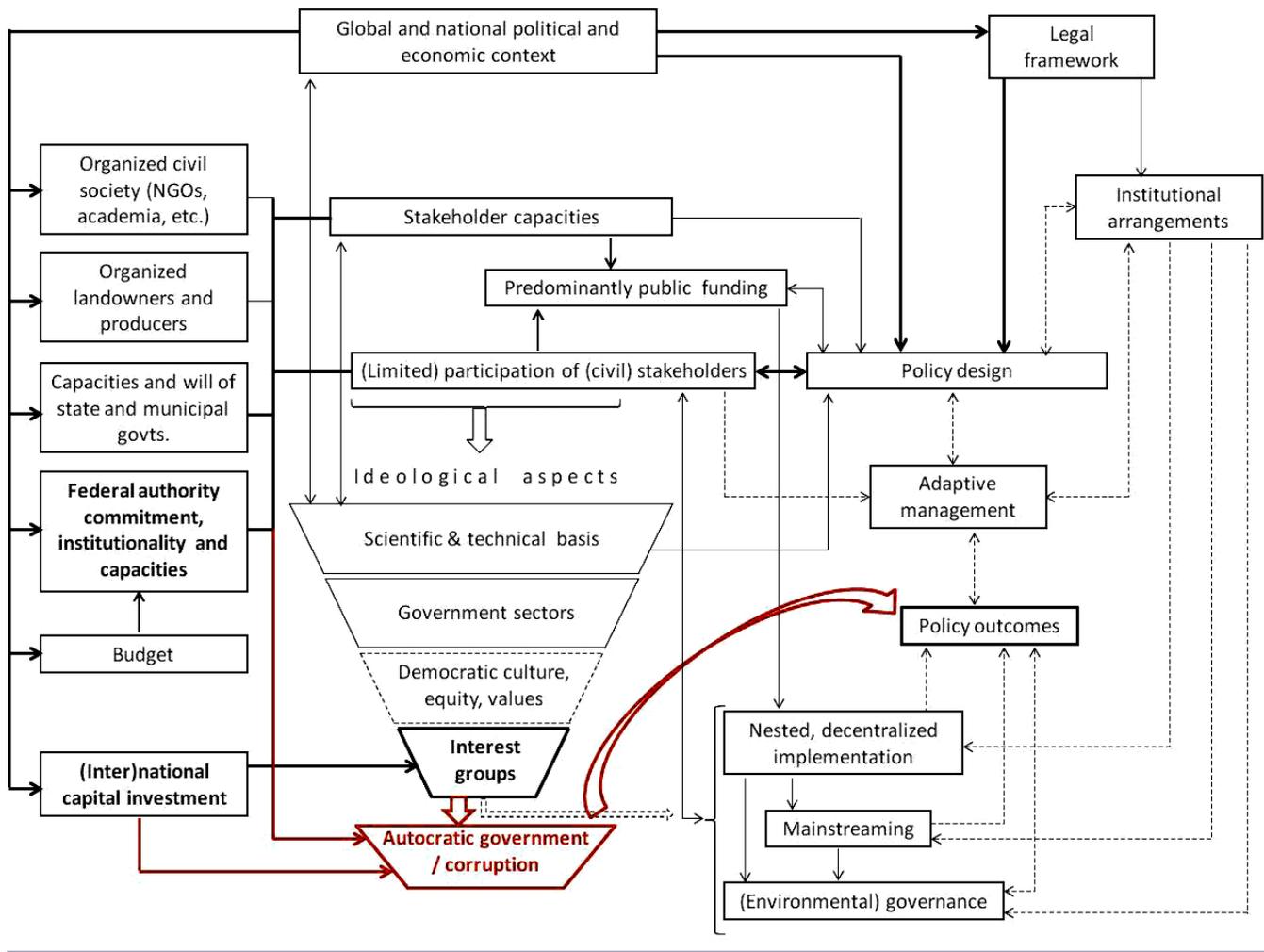
Figure 5 schematically synthesizes the policy process for Mexico’s environment sector, based on the inductive qualitative analysis. It illustrates graphically the principle relations of influence between the factors, policy attributes, and contexts discussed, including, superimposed in red, the most pernicious of the negative factors undermining it. Many of these relations of influence are bidirectional and mutually reinforcing.

The shortcomings identified by the experts in relation to the legal framework, institutional arrangements, stakeholder participation, and technical aspects weaken adaptive management (Fig. 5, centre right). The neoliberal, proglobalization stance of successive Mexican administrations has strengthened the hand of national and international investors, facilitating the free movement of capital between nations, in search of the cheapest commodities, labor, oil, resorts, etc. (Moore 2015). Ostensibly promoting development, the mobility of capital investors sets them apart from local stakeholders (Fig. 5, bottom left); their relative power strengthened by governments prepared to transform nature for jobs and wealth creation (Wise and Waters 2001, Tetreault 2012, Weaver et al. 2012, World Bank 2016). The experts recognize that such associations can involve acts of negligence, omission, complicity, or corruption by autocratic authorities to facilitate such initiatives, sometimes for political or economic gain. This can include efforts to reduce or circumvent environmental regulations and limit local or civil participation or opposition to development schemes (Yamin and Noriega García 1999, Williams 2009, Tetreault 2012, Weaver et al. 2012). This undermines the rule of law, effective democracy, governance, and policy success (factors in red, Fig. 5).

The top-down approach of capital investors and government reflects an attitude of aloofness from the relational networks of actors comprising the socioecosystem, in which they are, in fact, embedded. This attitude fails to recognize the interdependence of actors or to account for the knock-on, reciprocal effects such interdependence implies for the functioning, management, and coevolution of the socioecosystem as a whole (Fig. 1).

Figure 6 schematically illustrates how the policy process for Mexico’s environment sector might be strengthened and improved with the adoption of the socioecosystem approach. Although the ontological underpinnings of the socioecosystem concept and the policy attributes of the socioecosystem approach are considered by the scientists who advocate it, and most of the experts consulted, to be advantageous for environmental policy, we recognize that it cannot change human nature or eliminate vested interests. Nevertheless, it could, in theory, promote more equitable stakeholder participation (Fig. 6, at left) and a more transparent and inclusive discussion of policy options and potential outcomes, thereby reining in the influence of powerful vested interests and autocratic (or corrupt) government over the policy process and catalyzing improvements in governance, adaptive management, and policy outcomes (Fig. 6; Pretty 1995, Liberatore and Funtowicz 2003, Callon et al. 2009, Castillo 2011).

Fig. 5. Flow diagram of relations of influence between the factors that condition the formulation, implementation, and outcomes of environmental policy in Mexico. Source: Compiled by the authors based on the category system that emerged from the inductive qualitative analysis. Notes: Arrows indicate relationships between factors and the direction of influence of these. Darker fonts indicate factors and relations of influence that are strengthened relative to others, by the deficiencies of the status quo, by the deficiencies of the status quo, broken lines indicating factors and relations of influence weakened by them. Content in red indicates breaches of institutionality and/or legality.



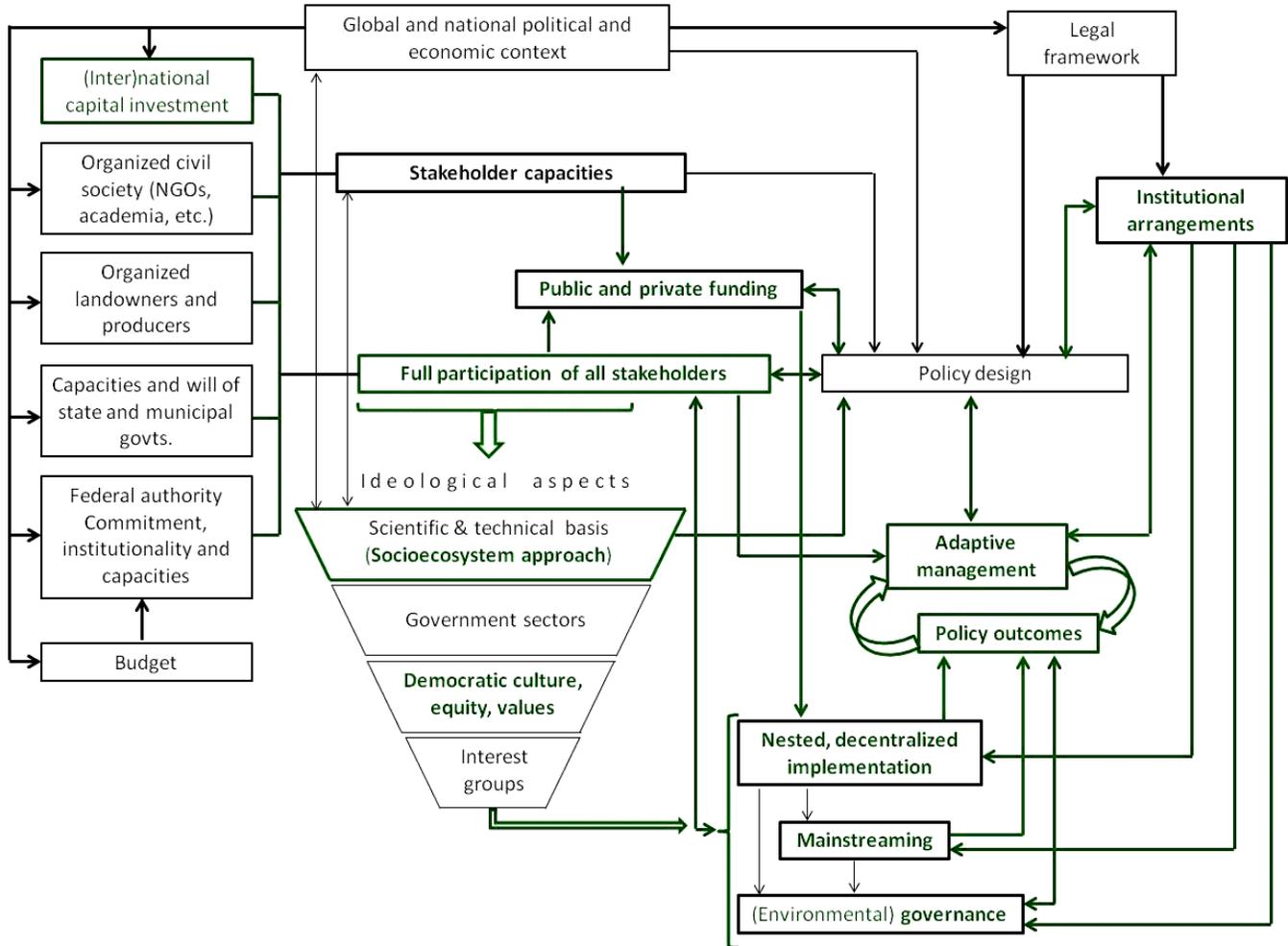
By consulting the experts, we learned that weak environmental governance and underdeveloped democratic values are key barriers to successful policy outcomes. However, we also learned that those policies that actively promote stakeholder participation in identifying common policy objectives (protected areas, basin units, and wildlife units) can help to improve governance. By extension, the policy attributes of the socioecosystem approach have the potential to democratize the policy process, by building interpersonal trust and strengthening democratic values, transparency, and governance, as each feeds into the other (Eade 1997, Assetto et al. 2003, Olsson et al. 2004, Flores 2005, Graf Montero et al. 2006; T. K. Ahn, *unpublished manuscript*). The sharing of information and the experience of collective decision making in such processes can even foster capacity building (Delgado-Serrano et al. 2016).

That environmental public policies specifically based on the socioecosystem approach have not been implemented to date by

any government, precludes a practical evaluation of whether the socioecosystem approach can in fact generate the benefits to society and sustainability its proponents claim (as well as limiting the scope of this study to eliciting expert opinion with regard to our working hypothesis, rather than testing it directly). Although the philosophical and ontological underpinnings of the socioecosystem approach appear solid, some political aspects have received less attention, leading critics to call for future research to prioritize such questions as: whose system framings count, whose sustainability gets prioritized, who decides what should be made resilient to what, for whom is resilience to be managed, and for what purpose (Lebel et al. 2006, Smith and Stirling 2010, Cote and Nightingale 2012)?

In the absence of socioecosystem-based public policies, research into community comanagement of ecological resources in Mexico from a socioecosystem perspective provides some useful feedback from real-life settings. It reflects many of the issues raised by the

Fig. 6. Hypothetical impact of adopting the socioecosystem approach on the relations of influence between factors conditioning Mexico's environmental policy process and its outcomes. Source: Compiled by the authors based on the two-tier category system that emerged from the inductive analysis. Notes: Darker fonts and lines indicate strengthened relationships. Content in green indicates the potential effects of incorporating the socioecosystem approach.



experts, while suggesting that the policy attributes we identify remain relevant at this scale, for successful outcomes. Examples include the selection and long-term monitoring of sustainability indicators for ecological, economic, and social variables (Manuel-Navarrete et al. 2006, Basurto 2008, Sosa-Cordero et al. 2008, Cinti et al. 2014, Defeo 2015, Delgado-Serrano et al. 2016), and effective institutional arrangements for rule enforcement and environmental governance at nested (local through to national) scales (Basurto 2008, Sosa-Cordero et al. 2008, Duer-Balkind et al. 2013, Cinti et al. 2014, Defeo 2015, Delgado-Serrano et al. 2016). It also confirms that well-devised, equitable participation mechanisms not only encourage multiple stakeholder involvement, but also drive knowledge acquisition, capacity building, and community empowerment via ongoing learning by doing and effective communication (Delgado-Serrano et al. 2016).

When local comanagement systems fail to produce sustainable outcomes, socioecosystem policy attributes are often absent or

underdeveloped. For example, effective governance is almost impossible when community self-organization and self-governance is weak, or when property rights are poorly defined, unrecognized, or unsupported by government (Cinti et al. 2014, Cervantes Gutiérrez et al. 2014, Poot-Salazar et al. 2015, Delgado-Serrano et al. 2016) because such legal and institutional frameworks are essential for the functioning of nested governance systems (Brondizio et al. 2009). At the other extreme, inflexibly conceived national policies, rigid institutional arrangements, and mistrust of government are also identified by communities as impediments to adaptive, sustainable resource management (Manuel-Navarrete et al. 2006, Cinti et al. 2014, Delgado-Serrano et al. 2016).

Mention should also be made of the Intermunicipal Environmental Board for the Integrated Management of the Lower Ayuquila River Basin (JIRA) in Jalisco state. It is Mexico's first and perhaps most innovative and successful example of a consultative governance structure devised to bridge the spatial

and temporal divides between different scales (sensu Brondizio et al. 2009). It links the governance of protected areas, municipal governments, and state governments (and their successive administrations), encouraging continuity, flexibility, compatibility, and transparency of management through broad stakeholder participation (Graf Montero et al. 2006, Maass et al. 2010b).

CONCLUSIONS

Consulting expert opinion, albeit indirectly, to gauge the receptiveness of environment sector officials to adopting the socioecosystem approach as the basis for future policy has provided a wealth of material beyond our initial expectations. The results of our study allow us to conclude that environment sector experts broadly concur with our working hypothesis, that the incorporation into environmental policy of those policy attributes conducive to the sustainable management of socioecosystems can potentially create opportunities to improve policy outcomes by addressing the obstacles that currently undermine environmental policy effectiveness in Mexico.

The experts consulted tended to consider those policy attributes characteristic of the socioecosystem approach as more conducive than others to successful policy formulation, implementation, and outcomes (Fig. 4). From this, we conclude that the favorable opinion of Mexico's policy experts represents an opportunity for incorporating the socioecosystem approach into environmental policy.

Among the potential obstacles to the adoption of the socioecosystem approach are several of the factors limiting the success of current policies. These include institutional barriers, such as the organizational, ideological, and conceptual boundaries between government sectors and tiers, and between the academic disciplines contributing to the theoretical frameworks of different policies and government sectors (Maass and Cotler 2007, Maass 2012).

Addressing these will require inter- and transdisciplinary efforts to bridge conceptual gaps and loopholes in the legal and technical frameworks and to ensure solid, workable, and flexible institutional arrangements for stakeholder participation and effective governance. Incorporation of the integrated drainage basin approach into all policies could potentially foster more coordinated and compatible policies, and obviate over-reliance on any one in particular. Community monitoring and citizen science could help redress the lack of data currently impeding adaptive management (Irwin 1995, Valentin and Spangenberg 2000, Riesch and Potter 2013).

In contrast with government officials, politicians tend to rely more on their world view and political ideology as guides to policy direction (Mukerji 1990, Daw and Gray 2005, Juntti et al. 2009, Young 2010a, Espinoza-Tenorio et al. 2011). In this context, larger obstacles to implementing a socioecosystem-based approach to environmental policy in Mexico, or elsewhere, are, potentially, the entrenched political and economic interests currently benefitting from the status quo. Associated with these are the deviations from legal, institutional, and democratic norms that can result from the single-minded pursuit of these interests by government, business, or other powerful stakeholders to the detriment of the less powerful, of public trust, good governance, and policy outcomes.

Although our study does not address directly Young's concept of "institutional fit" (Young 2002, 2008) and its recent development (for example, Epstein et al. 2015), several of the observations made by the experts (e.g., in regard to institutional arrangements) related to the problems of fit, interplay, and scale identified by Young as constraining the success of environmental institutions in terms of management outcomes. By extension, our study is also relevant to such broad research topics as environmental regimes (Young 1999), environmental governance (Lemos and Agrawal 2006), and policy implementation (deLeon and deLeon 2002). Although we do not discuss how the results of this study relate to these concepts and research topics because they were not our main focus, the information provided by the experts could certainly be analyzed in relation to them as the subject of future research.

Just as Young (2002) critiqued the usefulness of Ostrom's design principles for addressing common pool resources, their importance having been shown to be contingent upon many natural and social variables (Baggio et al. 2016, Barnett et al. 2016), so his concept of institutional fit is critiqued in turn as being vague and difficult to apply in practice (Cox 2012, Vatn and Vedeld 2012, Epstein et al. 2015). In part, this is because environmental regimes (institutions) are founded where pre-existing socioecosystems include pre-established institutions of all kinds, to which the problems of fit, interplay, and scale not only also apply, but become difficult to disentangle as individual factors (Vatn and Vedeld 2012).

These observations would suggest that institutional panaceas ensuring effective socioecosystem management outcomes do not exist, because success factors vary across different contexts (Acheson 2006, Epstein et al. 2015, Baggio et al. 2016, Barnett et al. 2016). As such, it is likely that some of the assumptions we make in our study are questionable, including the appropriateness of our 12 socioecosystem policy attributes for every potential case in which socioecosystem-based policy is the object of research or implementation. Another such assumption relates to the credibility of experts because they are often unreliable (Acheson 2006), both as sources of information for socioecosystem management (hence the need to encourage wide stakeholder participation) and in terms of their objectivity with regard to their own vested interests when responding to interview questions. In the context of the latter, although carefully phrased interview questions, such as we have attempted here, can help guard against such bias (and the results of the cluster analyses conducted indicate that none was detected), they can probably never eliminate the potential for it.

Responses to this article can be read online at:

<http://www.ecologyandsociety.org/issues/responses.php/10066>

Acknowledgments:

The authors are grateful to the 30 experts who gave their valuable time and experience so that this research could be undertaken, both the 20 government officials who responded so fully and frankly to the interview questions and questionnaires, and the 10 academic

experts who answered the questionnaires as well. Thanks are also extended to Dr. Paloma Cartón de Grammont Lara, for her helpful advice on some methodological issues and to Lucía Martínez of the Instituto de Investigaciones en Ecología y Sustentabilidad, UNAM, for her time and kind assistance with using Atlas-ti. The authors also thank three anonymous reviewers for their excellent and most helpful comments. The lead author thanks and acknowledges the Postgraduate Programme in Biological Sciences (Programa de Posgrado en Ciencias Biológicas) of the National Autonomous University of Mexico (Universidad Nacional Autónoma de México, UNAM), under the auspices of which this article constitutes an integral part of the research project conducted under the supervision of Dr. Manuel Maass, and undertaken for the degree of Doctor in Biological Sciences. The lead author also thanks and acknowledges the National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología, CONACYT) of Mexico, for the grant received for the duration of the doctoral research program.

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Appendix 1: Outline profile of the experts consulted

Twenty experts were consulted, four experts for each of the five policies, each sub-group of four being selected for optimum similarity of composition and expertise. Five of the experts consulted were women, fifteen were men, and all have held mid to high-ranking positions in government institutions in the environment sector of Mexico's federal government for at least two years, with most having over a decade of experience. Three had recently left government with the change of administration (December 2012), and one had just moved to a new agency within the Environment Ministry. Each expert agreed to respond to questions presented via semi-structured interviews, most of which were conducted in the interviewees' office, after first having answered a questionnaire, via email.

A further ten experts were consulted exclusively via questionnaires sent by email. This group of experts, comprising two women and eight men, have held very senior decision-making positions in the environment sector of the Mexican government (although most are retired from government), and/or have held senior positions in the regional offices of international conservation NGO's in Mexico, and/or in Mexican NGO's dealing with natural resource conservation and management. Almost all have doctoral level degrees and teach university undergraduate and postgraduate students in environment-related studies. This group was consulted, in the context of this analysis, to "triangulate" the responses of the larger group of 20 experts.

Appendix 2: The rationale underlying the questionnaire and the semi-structured interview

To ensure robust and credible results for this study, two kinds of triangulation were employed: 1) methodological triangulation and 2) data triangulation (Patton 2002: 247).

The methodological triangulation involves using both a standardized questionnaire, to which responses constitute ordered categories of opinion that can be weighted to generate numerical data suitable for a ranking analysis, and a semi-structured interview, which elicits more detailed and conceptual information on the same subject matter, suitable for qualitative analysis. Both analyses detect the level of shared opinion among the 20 “policy experts”, while also allowing comparisons to be made between the five policy sub-groups.

The ranking analysis of the questionnaire data allows the responses of the 20 “policy experts” to be triangulated using the responses of the 10 “academic experts” (who were not interviewed), by comparing between the two sets of responses.

The questionnaire

The questionnaire was sent to each expert for completion and return prior to the interview, both to stimulate thought on the topics of interest (five environmental policies and a range of policy attributes), and to avoid as far as possible introducing any bias or change of perception which might result from sending the questionnaire after the interview, given its deeper exploration of the issues.

Each (identical) questionnaire included an exercise, in the form of a table, for which each expert was asked to rank 27 policy attributes in terms of their relative importance in the formulation and implementation of effective environmental policies (Table A2). The aim was to see how much importance each expert attached to the 12 attributes characteristic of socioecosystem management (two of which were subdivided, giving 15 in all). The experts had no prior knowledge of the significance of these in the context of the study, and a further 12 attributes, not characteristic of socioecosystem management but addressing related aspects (and which are also employed in formulating environmental policy in Mexico), were added to the list to increase the range of options and reduce bias. It was stated that no “correct” answers exist, that it was valid to rank all attributes equally or to give mixed responses, and experts were invited to suggest additional attributes.

For the ranking analysis, each expert’s response, signalled with a cross in the box of their choice at the intersection of a row and a column, was assigned a numerical weight. Given that the table has six columns with hierarchically ordered categories of opinion, increasing in favourability from left to right with a “don’t know” option in the last column, responses were weighted, left to right, with: 0, 1, 2, 3, 4, and 0 (it was considered unhelpful to assign any other weighting to the “don’t know” option).

Table A2. Relative importance of policy attributes for effective policy outcomes

	Potential policy attributes for the formulation and implementation of environmental public policy	Relative importance					
		None	Little	Some	Much	Crucial	Don't know
1†	Ecosystem approach						
2	Habitat approach						
3†	Drainage basin / sub-basin approach						
4	Zoning based on environmental criteria						
5	Prioritization based on socioeconomic criteria						
6	Short-term duration (years)						
7	Medium-term duration (government administrations)						
8†	Long-term duration (decades)						
9	Technical involvement from a scientific discipline						
10†	Interdisciplinary technical involvement						
11	Sectoral autonomy (limited, discretionary mainstreaming)						
12†	Environmental mainstreaming						
13	Exclusively public funding						
14†	Public-private funding						
15	Submit developed proposals to public consultation						
16	Sporadic public participation						
17†	Continuous public participation						
18†	Environmental governance						
19†	Fluid communication between stakeholders						
20†	Governmental subsidiarity (decentralization) [§]						
21†	Coordination between the three tiers of government [§]						
22	Indicators of regulatory and procedural compliance						
23†	Sustainability indicators						
24	Clear, fixed targets						
25†	Adjustable targets (what is possible relative to what is desirable) [‡]						
26†	Results monitoring						
27†	Adjustments to management based on evaluation and monitoring [‡]						
28	Other (specify)						
29	Other (specify)						
30	Other (specify)						

† = Attributes of socioecosystem management (these were not marked with an asterisk in the questionnaires sent to the experts).

§ = Component attributes of multi-scalar, polycentric environmental governance.

‡ = Component attributes of adaptive comanagement.

On receiving all the completed questionnaires, the responses were collected in seven tables identical to that included in the questionnaire, five aggregating the responses of the sub-groups of experts (one for each of the five policies), one aggregating the responses of all 20 policy experts, and one aggregating the responses of the 10 academic experts. For each of these, the number of coincident responses in any given box at the intersection of a row and a column was multiplied by the corresponding pre-assigned weighting, to give a score. The sum of the scores in each row, expressed as a numerical total, was then ranked from highest

to lowest to reveal how the expert groups collectively appraised the concepts expressed in the rows.

The semi-structured interview

Each interview contained the same set of 14 questions (with five additional prompt questions, if needed), and differed only in the name of the policy. The content and length of the responses were up to the interviewees, and most interviews lasted for about one hour (For the full list of interview questions see Appendix 3).

The first questions focussed on each interviewee's direct area of expertise, in terms of the policy for which she/he was responsible, and the factors that contribute to or obstruct its successful implementation. Subsequent questions invited opinions on other policies, and explored the interviewee's perceptions regarding specific policy attributes (without revealing that they are characteristic of socioecosystem management or what that is), and their role in the successful implementation of the policy.

This sequence of questioning laid the conceptual groundwork for introducing the socioecosystem concept at the end of the interview, including the reading of a brief working definition of a socioecosystem approach to environmental management, drawing on and integrating ideas from several sources (Gallopín 1994, 2001, Valentin and Spangenberg 2000, Gunderson and Holling 2002, Liberatore and Funtowicz 2003, Olsson *et al.* 2004, Haberl *et al.* 2006, Maass and Cotler 2007, Brondizio *et al.* 2009, Ostrom 2009, Domínguez 2010, Collins *et al.* 2011, Maass 2012). The interviewee's opinion was then elicited as to how the socioecosystem approach compares with their particular policy, and whether they perceived advantages or disadvantages in the socioecosystem approach as a basis for environmental policy.

Before concluding the interview, each expert was invited to share their suggestions as to how to improve Mexico's environmental policy.

Appendix 3: List of the 14 interview questions, which were grouped by subject matter into 11 "question codes" generated during the qualitative analysis of the data, aided by Atlas-ti.

Interview questions		Question codes	
1	I should like to start by asking which policy attributes you think contribute to the success of (this policy)?	1	Contributes to success
2	Do you consider that any obstacle or obstacles exist to the successful implementation of (this policy)?	2	Obstacles to success
3	In reference to (this policy), what has been most effective in articulating between sectors and/or tiers of government? 3a) To what do you attribute this?	3	Mainstreaming (this) policy
4	Considering the environment sector as a whole, in your opinion which public policies have been most effective at articulating between sectors and tiers of government? 4a) To what do you attribute this?	4	Mainstreaming (other) policies
5	What is your perception of environmental policy based on integrated drainage basin management in Mexico?	5	Integrated basin management
6	What do you understand by "environmental governance"?	6	Environmental governance
7	Environmental governance can be considered as the capacity of institutions, laws and coordination arrangements, both governmental and non-governmental, to articulate the polycentric implementation of the policies of environmental management across different spatial and temporal scales, in the social and natural spheres. Thus understood, how relevant do you consider environmental governance to be for the implementation of (this policy)? 7a) Why?		
8	What measures might improve environmental governance in Mexico?	7	How to improve governance?
9	What do you understand by "adaptive management", as it relates to environmental policy?	8	Adaptive management
10	Adaptive management can be considered a process of policy implementation based on feedback from (social, environmental, economic, etc.) indicators relevant for sustainable development generally, and for achieving the specific objectives of policies. If the monitoring of these indicators suggests a deviation, in the medium- or long-term, from sustainability goals or criteria, adjustments can be made to how a policy is implemented, so as to reorient it towards the most feasible of desirable outcomes. Thus understood, how relevant do you consider adaptive management to be for the implementation and effectiveness of (this policy)? 10a) Why?		
11	What do you understand by the concept of socioecosystem or social-ecological system?	9	Socioecosystem approach
12	The concept of the socioecosystem recognizes that human beings are agents of change integral to ecosystems, and not external to them as is generally considered, and that social systems are totally dependent on ecosystems. Traditionally, environmental public policies are formulated based on the natural sciences, while social and economic policies are based on the social sciences. The concept of the socioecosystem posits an interdisciplinary contribution to the formulation of public policies which address sustainable development and environmental management simultaneously. The socioecosystem approach requires several policy attributes, including scientific interdisciplinarity, full public participation, and environmental governance jointly achieved by all tiers of government together with civil organizations. It should also incorporate adaptive management based on the monitoring of sustainability indicators, in order to adjust policy implementation measures when necessary, taking into account both the objectives of policy and the responses of the socioecosystem to management. It is suggested that such an approach to policy can improve the resilience of socioecosystems to sources of disturbance, such as climate change. Thus understood, what are the similarities between the socioecosystem concept and (this policy)?		
13	Do you consider that the socioecosystem approach offers advantages or disadvantages for environmental public policies in Mexico? 13a) Why?	10	Socioecosystem offers advantages or disadvantages?
14	Before concluding the interview, would you like to share any other ideas about Mexico's environmental policy, in terms of improving its effectiveness, comprehensiveness, contribution to sustainable development, etc.?	11	How to improve environmental policy?

Appendix 4: Two-tiered explanatory category system grounded in related codes and memos

No. †	Code or Memo	f‡	Level 1 categories§	Level 2 categories
M1	The root problems are political, and the economic model	5	International political and economic context	National and international political and economic context
1	The globalized economic system causes environmental and socioeconomic deterioration	11		
2	International pressures /obligations	9		
3	Economic value of Natural Capital must be shown, to give political weight to the environment sector	16		
4	Opposition and pressure from political, economic, social or criminal vested interests	64	National political and economic context	
M2	Power structures in Mexico are resistant to change	4		
5	Budgetary constraints	37		
6	Generous programs of subsidies to encourage agricultural production, provoke environmental deterioration	16	Legal strength	
7	The Presidential Decree gives greater solidity	9		
8	To induce sustainable development and conservation, regulation, not prohibition of resource use (is required)	64		
9	The legal framework (should be more explicit and binding)	155		
10	Lack of legal obligations and sanctions for non-compliance	36	A clearer, more explicit and binding legal framework is required	Strengths and weaknesses of the legal framework
11	The confluence of potentially conflicting jurisdictions and attributions in a given territory	49		
M3	It is difficult to target subsidies and programs in priority areas	4		
12	A long-term planning framework for public policy (is lacking)	46	The legal framework makes the spatial and temporal focussing of policy implementation difficult	
M4	The Planning Law (timeframe = a single, six year administration), needs updating	6		
M5	Ecological land-use planning IS the long term planning framework	5		
M6	Conflict between Ecological land-use planning and Territorial planning (of local government)	5		
13	The concept of “territory” is required, to locate the human-nature relationship in geographical space	25	Conflicting spatial approaches	
14	The ecosystem / habitat approach (is required)	12		
15	The sound scientific and technical basis of the policy, i.e., environmental and socioeconomic data and criteria, etc., (is required)	78	A more integral and interdisciplinary technical basis is required	
16	A holistic / integrated approach is lacking	91		
17	Interdisciplinary working (is lacking)	14		
M7	Include non-scientific knowledge	10		
18	Indicators and data on local factors and on the results of policy implementation (are lacking)	32	Strengths and weaknesses in the implementation of adaptive management	Strengths and weaknesses of the technical basis of policy
19	The policy includes monitoring and evaluation	29		
20	The monitoring and evaluation of results (is lacking)	47		
21	[08 Adaptive management] ¶	99		
22	Flexibility in policy implementation (is lacking)	26	Strengths of drainage basin management	
M8	Water as an indicator	9		
23	[05 Integrated drainage basin management]	129		
24	Integrated drainage basin management is ideal for territorial management, because it includes all elements and actors	59		
25	Incorporation of the drainage basin management approach in other environmental policies	25	Weaknesses of drainage basin management	
M9	Incorporation of the drainage basin management approach in other environmental policies	3		
26	The scale of the drainage basin is too large	8		
27	The ideal territorial delimitation for implementing drainage basin management approach is the sub-basin or local basin/watershed	9	Institutional redesign is	
28	A genuine public policy for integrated drainage basin management does not exist	23		
M10	Institutional redesign	12		

M11	Cyclical collapses are necessary for institutional renovation	1	required	Strengths and weaknesses of institutional arrangements
29	Integrated planning and coordination of the areas and policies of the environment sector (are required)	143	Institutional arrangements for fully coordinating the areas and policies of the environment sector are ineffective	
30	There is a need to acknowledge and correct the excessive emphasis on Protected Natural Areas	18		
31	Ecological functionality and biodiversity must be conserved in the wider landscape, outside Protected Natural Areas	26		
32	Communication and dissemination (is required)	75		
33	Nested, decentralized and coordinated administration (is lacking)	45	Institutional arrangements for a nested, decentralized and coordinated administration, are ineffective	
34	An administrative entity to coordinate all actors at local level (is required)	31		
M12	With a policy / arrangement like an administrative entity to facilitate collaboration at local level	57		
35	Field staff (are lacking)	10	Factors that facilitate the mainstreaming and coordinated implementation of policies	
36	Effective institutional arrangements for mainstreaming and coordinating between the different sectors and tiers of government (need to be developed)	218		
37	[03 Mainstreaming of the expert's particular policy]	171		
38	Subsidy programs and projects	49		
39	Common objectives to facilitate coordination between different actors (are lacking)	44		
40	Prevention and response to natural disasters and social conflicts	11		
41	Government investment that conserves or adds value to Natural Capital, and encourages producer organization	20		
42	Complementarity with other environment sector areas and policies	36		
43	Water as a cross-cutting issue across all sectors and tiers of government	25		
44	In principle, Ecological land-use planning orientates and coordinates the activities of all sectors and tiers of government in a given territory	37		
45	[04 Mainstreaming of other environmental policies]	185		Policies that facilitate mainstreaming and coordinated implementation
46	Any policy, according to circumstantial rather than intrinsic factors	13		
47	In principle, Protected Natural Areas	12		
48	CONAFOR's payment for environmental services policy	7		
49	Other policies / arrangements	45		
M13	REDD+ early action sites policy	12		
M14	Biological Corridors	8		
M15	Community Ecological land-use planning	7		
M16	Rural Development Districts	6		
M17	The Crusade against Hunger	4		
M18	Environmental Impact Assessment	4		
M19	National Development Plan and Sector Programs	4		
M20	Climate Change Policy	3		
M21	Basin Commissions	2		
M22	Wildlife units	2		
M23	Planning Committees for State Development (COPLADES)	2		
M24	Inter-Secretarial Commissions	1		
50	Inter-personal work relationships can advance environmental policies and issues	18	The full participation of all actors and stakeholders is required	
51	Participation of organized landowners and producers in the design and comanagement of natural resource policy (is required)	141		
52	Full participation / appropriation by organized civil society, i.e., NGO's, academics, etc., (is lacking)	136		
53	Participation / appropriation by state and municipal governments (is lacking)	60	Better organized and skilled local and social stakeholders are needed	
54	A society and end users with better education and capacity development are needed	33		
55	Well organized producers / social actors (are needed)	35		
56	A lack of trained and committed technical experts	13		
57	A lack of technical, political and budgetary capacities in state and municipal governments	50	More personnel with adequate capacity and training are needed in	
58	The interviewee understands the concept	45		
M25	The interviewee does not seem to understand the concept of adaptive management	3		
59	The interviewee confuses "governance" with governability or government	18		
60	The interviewee did not venture a definition	8		

61	The lack of environment sector personnel with adequate capacity and training	71	the environment sector	
62	Negative repercussions of changing personnel and priorities with each administration	50	The strength and direction of environmental policy changes with administrations	The strength of environmental policy depends more on the personal convictions of political leaders than on institutional strength
M26	Backtracking by the current administration	25		
M27	Advances in the current administration	3	Lack of priority and political commitment	
M28	The strength of environmental policy depends a great deal on the incumbent President	8		
M29	There is a lack of leadership from the Environment Minister	3	Lack of institutionalities from environmental authorities	
63	Effective political commitment, leadership and prioritizing (is lacking)	148		
M30	Deficiencies of PROFEPA [Federal Attorney General for Environmental Protection]	17	Corruption, abuses of power and lack of transparency	A crisis of governance exists in Mexico
64	Environmental authorities should do more to uphold and enforce the law	50		
M31	CONAGUA: Powerful but lacking a vision and policies which are integral and institutional	40	Crises of trust, of values and of security, in Mexican society	
65	The cultural inertia of centralized authority needs to be overcome	32		
66	The lack of institutionalities in public administration, due to cultural factors and to political and economic vested interests	99	Effective management relies on environmental governance	
M32	Ecological land-use planning was not utilized	3		
67	It is counterproductive that environmental authorities themselves engage in corrupt practices, abuses of power and law breaking	28	Governance is not a political priority	
68	A healthy, i.e., non-clientelist, relationship between authorities and social actors (is lacking)	11		
M33	¿Paternalism / clientelism?	11	Deficient application of environmental policies limits their success	
69	Delays and bureaucratic complications	22		
70	Transparency and accountability (is lacking)	36	Similarities between the socioecosystem approach and environmental policies	Advantages are perceived in the integrality of the socioecosystem approach
71	Credibility of authorities (is lacking)	11		
72	The lack of trust that exists in Mexican society, is a barrier	27	The socioecosystem approach offers advantages because it is holistic	
73	A culture and values of democracy and legality in Mexican society are lacking	50		
74	The common good approach is lacking, and self-interest or group-interest predominates	37	Others	
75	(Attention to) Poverty and social necessity	44		
M34	Insecurity, criminality	12		
76	[06 Environmental governance]	123		
77	It is fundamental / very important for effective implementation	52		
78	Policies which rely on, or promote, governance	18		
79	[07 How to improve governance]	135		
80	Governance has not been defined, adopted or prioritized, politically	23		
81	It is a political fad	15		
82	Governance (is lacking)	23		
83	Deficiencies of application	115		
84	[02 Obstacles to success]	314		
85	[11 How to improve environmental policy?]	192		
86	It is not a successful policy	8		
M35	Forestry units do still exist	3		
M36	CONAFOR: Counterproductive forestry policies	8		
87	[09 The socioecosystem approach]	84		
88	Is the socioecosystem approach similar to your policy? Yes, or somewhat	28		
89	Is the socioecosystem approach similar to your policy? Doubts about this	11		
90	Is the socioecosystem approach similar to your policy? No, or very little	15		
91	Doubts about the implementation of the socioecosystem approach in practice	22		
M37	It may not be compatible with the social policies of SEDESOL [Ministry for Social Development]	3		
92	[10 Does the socioecosystem approach offer advantages or disadvantages?]	61		
93	Advantages, because it is holistic	39		
94	The socioecosystem approach will facilitate integral management	8		
M38	The socioecosystem approach concept is starting to be adopted in public policy in Mexico	3		
95	[01 Contributes to success] #	151		
M39	It seems that this is not describing a Wildlife unit	1		

Source: Compiled from the code and memo lists generated in *Atlas-ti*, using inductive analysis based on grounded theory (Patton, 2002; Hernández-Sampieri et al. 2006).

Notes:

† = Numbers with the prefix “M” refer to the 39 memos, the others refer to the 95 codes.

‡ = Frequency (*f*) of use of the code or memo (number of associated quotations = *groundedness*).

§ = Dashed lines separating categories indicate they can be thought of as grading into each other and share adjacent codes.

| = A suffix in parenthesis such as “(is lacking)”, signals that a code can have a positive connotation (without the suffix) or a negative connotation (with it). In “(Attention to) Poverty and social necessity”, this logic is reversed.

¶ = Numbered codes in squared brackets are question codes.

= This code appears here because for the experts, obstacles outweigh by 2:1 the factors contributing to policy success.