

Studying Social-ecological Systems from the Perspective of Social Sciences in Latin America



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Abstract Latin America can be understood from multiple perspectives, due to its high biological and ecosystemic diversity, intertwined with myriad historical, cultural, social, economic, and political contexts that together condition its social-ecological systems (SES). However, frequently within academic and management agencies, dominant paradigms and models have been imported from the Global North. Consequently, there is a need to recognize and incorporate local and regional (i.e., context-specific) characteristics to understand the SES of territories where there are complex interdependences.

In this chapter, we propose to enhance a Latin American SES perspective by “culturalizing” the ecosystem and the environment, which we perceive as a necessity to understand the interdependence occurring in specific territories. Here, we discuss specific social science contributions to the SES framework by recognizing the influence of Latin American efforts, like the *Modelo Mundial Latinoamericano*. We also conduct a philosophical analysis to compare the SES history and paradigm as a “trialogue” with territorial development, political ecology, and social science disciplines that are well-developed in Latin America. Moreover, we look at how

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Ostrom's SES analytical framework has been operationalized in Mexico. Finally, a literature review of SES publications was conducted to determine the state-of-the-art regarding achievements and challenges for social sciences.

Keywords Social-ecological systems · Latin America · Complexity · Social sciences · Ecosystems · Cultures

1 Introduction

It is a common practice to talk about systems in many natural and physical sciences, such as ecology, geology, or physics; however, systems theory and models are also useful concepts to explain social phenomena. In this chapter, we consider why social science disciplines should include or are already including the spatial and temporal scales required to understand complex human-nature relationships that recognize territorial processes as part of integrated social-ecological systems (SES). Indeed, such an assessment is necessary because the issues and problems that were traditionally categorized as “environmental” and approached from the perspective of the biophysical sciences (e.g., climate models of global warming) are increasingly recognized as possessing both social causes *and* consequences (e.g., energy policy and socio-economic impacts of desertification) (IPCC 2018). In turn, traditional “social” concerns (e.g., territorial planning, immigration policies, and social justice) are increasingly understood as being affected by the degradation of biodiversity and ecosystems (e.g., emergent diseases in fragmented landscapes and loss of traditional resource-based livelihoods) (Lira-Noriega and Soberón 2015; IPBES 2018a).

Still, though disciplinary in-breeding and biases are common, even when scientists employ formalized methods to obtain knowledge with the goal of answering questions about these phenomena, and for this reason, some cross-disciplinary marriages—known as interdisciplinarity and transdisciplinarity—have arisen along the lines of political ecology, ecological economics, social ecology, etc., challenging old conceptualizations of separating humans and nature to propose new integrated paradigms as part of ongoing scientific revolutions, *sensu* Kuhn (1962). Multiple paradigms that can support systems thinking are also well established in the human/social sciences. For example, criticism and phenomenology in geography, functionalism in sociology, relativism in history, and Keynesianism in economics are just a few examples of paradigms used for determining what is “normal social science.” But this diversity of theoretical frameworks and core concepts allows us to understand the foundational premises of our scientific communities and cultures. Indeed, systems thinking is a way to abstract reality by organizing it into elements, components, structures, subsystems, and systems, and where we envision humans in these systems is critical to defining the object/subject of study and how to explore or manage it.

In this context, the interaction between social and ecological systems is emerging as a one perspective for understanding the complexity surrounding and embedded in socio-environmental problems, which are being exacerbated by global ecological and climate changes. Even though Latin America has been highly influenced by the paradigms proposed in developed countries, a lack of stability in national scientific policies during last decades has created a crucible that motivates social scientists to re-think their own paradigms by confronting decades of economic fluctuations, poverty, biodiversity loss, climate threats, war and violence, and the multiplicity of situations derived from unattained sustainable development goals. Furthermore, in a world where social sciences are threatened by their political status or governments' economic recipes, they are often marginalized even within academia, and including them in the SES perspective provides a dynamic tool to develop knowledge for studying complexity in the interdependence of communities and the environment (Scholz and Binder 2003, 2004), such as integrated ecosystems and their implications for environmental services (Castro-Díaz 2014), adaptive governance (Folke et al. 2005) and water governance (Pahl-Wostl and Kranz 2010; Pahl-Wostl et al. 2010), social vulnerability and ecosystems services feedback (Castro-Díaz and Natenzon 2018a), and water provision and land cover changes (Castro-Díaz and Natenzon 2018b). Therefore, the study of socio-ecological problems should be considered by paying attention to their complexity and functioning from a systemic (integrated) vision, which changes over space and time (García 2006: 21; Farhad 2012; Castro-Díaz 2017).

Understanding the SES causes and consequences of these relationships allows us to find solutions in a functional (and ethical) way, starting with the origin of the problems and then addressing related actions from the complexity of specific situations. The term complex systems can be considered from the paradigm that reorients scientific thinking toward the complexities, wholes, and open dynamic systems that are present throughout the world (García 2006). The main components of a complex system, as proposed by García (2006), are (1) limits (spatial and temporal), (2) structure (hierarchy of components), (3) scales (of interaction), and (4) processes. In this sense, engaging that which is "complex" allows researchers and managers to emphasize on the composition of an entire system and on the heterogeneous elements in constant interaction with each other, immersed and surrounded by other systems. This perspective, in turn, requires an integrative, inter- or transdisciplinary approach (Castro-Díaz 2017; Merçon et al. 2018).

In recent years, a great interest has been observed in the development of academic studies and public-policy instruments that incorporate the concept of SES, promoting the publication of numerous investigations on analytical frameworks, related concepts, and ways of operationalizing based on causal relationships (Perevochtchikova 2016; Avila-Foucat and Perevochtchikova 2018). The concept of complexity, therefore, contributes to the analysis of these current ecological, social, and economic problems and crises, such as climate change, poverty, injustice, and environmental degradation, among others. It seeks to understand a world in constant transformation and adaptation (or not) to the influence of internal and external

stressors or “shocks” through the dynamics of self-organization and self-development (Postigo et al. 2013) with profound epistemological, ontological, and ethical implications.

2 “Culturing” Ecosystems Through the SES Concept

The idea that we live in a time of catastrophe and harm leads humans to be conceived of as aliens to Mother Earth, and this perspective has become well-established in many academic and policy discourses. Indeed, there are major reasons to support it, including climate change (Weart 2008), the modern species extinction crisis (Thomas et al. 2004), the mass extinction of the Australian fauna (Roberts et al. 2001), or the European invasion to the Americas and their devastating ecosystem modifications (Koch et al. 2019). However, this phenomenon can also be considered from the lens of what it means to our cultural relationships to nature.

The idea of “culturing” nature encompasses all actions taken by the human being as an individual (indivisible), community, or society with ecosystems. Its implications, of course, are as diverse as the disciplines of social and human sciences, especially when they are referred to multiple explanations, theories, models, schemes, and all approaches to the human dimension at every possible scale. They are numerous and varied that we should define the socio-ecological relationship as the focus of our attention that, even with constraints, it solves the issue of the metaphor of human actions on the ecosystem as a result of their cultural activities. For understanding the ways of “culturing” nature, we can refer to Nisbet et al. (2009), which states that every aspect of the human life is related to the environment (i.e., natural relatedness). Morin (2009) includes this approach when considering the relationship with the whole to the parts and propose complexity as a feature of the link they hold. This link, in turn, is built into so-called “time-space,” a concept that grew from geography and refers to the territorial processes holding the spatial dependence and the temporal causality (Pillet 2004) and including territorial changes between the present and the past for a given location. For example, the way to study a currently flooded valley, a cut forest, the city of Brasilia, and global change are all the result of spatial-temporal dynamics. This “culturing” of nature approach has been developed in several social/human sciences, such as geography or anthropology. However, it can include every such discipline (e.g., sociology, psychology, health, economics, engineering, and others) that can locate their field of study in the diversity of territorial processes.

For comprehending an SES with a social sciences lens, we should, therefore, determine its ecological foundations, but also its expression in human spatial-temporal relationships to understand the dynamic agent causality of human beings. Even though anthropic actions are widely evident in our planet, the study object/subject being investigated with the SES framework needs to recognize that humans go beyond the negative prejudice that many natural and physical sciences have established and instead incorporate a social science perspective that acknowledges

societies interacting reciprocally with ecological fluxes. There are multiple examples for identifying these types of socio-ecological relationships: religion, cosmovision, technology, energy production, urbanizations, tourism, agriculture, scientific production, transport, and others such as processes intervening, modifying, and conditioning the ecosystem (see also chapter “Social-ecological Complexities and Novel Ecosystems” in this volume). In short, the social science SES perspective conceives anthropogenic action as part of the ecosystem response, and at the same time, it cannot be studied without appeal to human dimensions that span social, cultural, religious, political, and economic factors.

3 Social Sciences Contributions to SES in Latin America

Globally and regionally, SES scholarship has been based largely on the dominant natural science discourses and paradigms that have influenced a global “brain circulation” of these ideas (Anderson et al. 2015a). However, we seek to contextualize this narrative by putting it into dialogue with social science traditions from Latin America, which to date have been sub-alternate voices. To diagnose the role of Latin American social sciences, in this section, we identify both their achievements, but also their gaps, or what de Sousa Santos (2006) has called a “sociology of the absent,” to understand when, where, and why they have been present (or not).

We put forward that Latin America has traditions that can support and enhance regional and global SES research and practice, which is relevant to global efforts to recognize multiple approaches, stakeholders, and worldviews in SES (e.g., Díaz et al. 2015). To test that assertion, we explore here three specific avenues of analysis: (a) a socio-historical perspective of how Latin American scholars have confronted and responded to dominant SES ideas that arise (and often are imposed) from the Global North, the developing of the *Modelo Mundial Latinoamericano* as a reaction to Meadows et al. (1972); (b) a philosophical (epistemological and metaphysical) evaluation of SES in relationship to territorial development (TD) and political ecology (PE), social science fields that are well-developed in Latin America; and (c) an operationalized use of Ostrom’s SES framework for understanding multilevel and multiscale interaction, using case studies focused on Mexico’s research experiences to see the ways that social sciences have been involved.

The History of the Modelo Mundial Latinoamericano

Understanding Latin America’s (potential) contribution to the SES debate requires having a historical perspective. When “environmental” problems were capturing the Western (or “Northern”) imagination around the 1960s and 1970s (Estenssoro 2007), Latin American scholars quickly recognized that this environmental crisis

was not only ecological, nor merely driven by human demands (e.g., population growth, migration from rural to urban areas, and subsequent urban expansion), but it was also intimately related to human quality of life, social well-being, justice, and equity. In particular, marginal peoples' lives were being greatly affected by these environmental changes. At the same time, though, in the Global North, the world's marginal people were thought of as a "population bomb" (sensu Ehrlich 1975) that was largely considered by developed countries to be the main driver of the environmental and civilization crisis. Arising from this thinking, we see such seminal reports as the Meadows et al. (1972) *Limits of Growth*, which proposed a global model (World3) for rationalizing sustainable human use of resources, based largely on reducing consumption by reducing birth rates (particularly in the Global South).

Based on the treatise *Catastrophe or New Society?* (Herrera et al. 2004), the Latin American World Model (*Modelo Mundial Latinoamericano*, Goñi and Goin 2006) was developed, whose name is important in itself because it purports to be a global model (*modelo mundial*), like Meadows et al. (1972), but, as is frequently the case when the social science perspective is brought to bear, it recognizes its own subjectivity by identifying where it comes from (*Latinoamérica*), rather than being some disembodied idea about a supposedly objective reality. Furthermore, *The Limits to Growth* had a universal conceptualization of humans and undertook a neo-Malthusian approach to the issue, based on resources and reproduction (i.e., a biological approach), where central countries ceased their ever-increasing consumption and peripheral countries ceased their population growth. The Latin American model introduced a novel and integral approach to the issue of sustainability and development by considering the satisfaction of humanity's "basic needs" of food, housing, education, and health for everyone as a way to reach a balance between society, nature, politics, and the economy. During this same time, "Northern" development agencies like the International Monetary Fund and World Bank were only looking at economic variables (Oetiza 2004).

The Latin American approach differed from that which was reflected in the *Limits of Growth* and validated by the countries members of the Club of Rome because it explicitly recognized its own normative character, as well as the power dynamics that are inherent in decisions regarding natural resources and human well-being. While Meadows and colleagues concluded that if their recommendations were not considered, then catastrophe would be imminent, the work derived from the Latin American report reveals that two thirds of humanity already was living a catastrophe, as impoverished and marginalized people. So, in this way, they asserted that the Club of Rome's report did not address the real problem. Of course, as Gallopin (2004) observes, both models have embedded values, but only the *Modelo Mundial Latinoamericano* makes them explicit, which is a hallmark of a social science perspective.

The historical perspective provided by this exemplary case study, however, also illustrates how social science ideas and their impact in the SES debate between the Global South and North are contextual and conditioned by broader societal processes. An inherently unequal power relationship regarding the production and dissemination of its proposal (e.g., it was not fully recognized by the national and

international academic community, Goñi and Goin 2006), but the *coup d'état* that installed the Argentine dictatorship in 1976 coincided with the final stage of its work and truncated its continuity and potential influence on regional and global debate and outcomes. Therefore, an entirely external socio-political process in Latin America vitiated the ability of Latin American thinkers, particularly social scientists contribute to these SES issues at the regional and global scales in dialogue with the dominant, natural science-based ideas of Meadows, and others.

A Trialogue Between Social-ecological Systems, Territorial Development, and Political Ecology

SES research shares a common study object/subject (human-nature interface) with territorial development (TD) and political ecology (PE), but each has different philosophical foundations and assumptions that can hinder productive collaboration. While SES arose largely in the context of the ecological sciences striving to integrate a human dimension, TD and PE came from social science traditions to understand the environment. In this way, we would expect them to have both epistemological and metaphysical similarities and differences, which demand attention to put them into constructive “trialogue” and avoid unconstructive arguments in the context of Latin American interdisciplinary socio-ecological research. To test this hypothesis, we analyzed these three fields from historical and philosophical perspectives to see where they complement, contradict, and/or enhance one another to be able to promote interdisciplinary (or integrated) studies in Latin America of complex human-nature dynamics in the Anthropocene (Table 1).

SES, TD, and EP are relatively young academic fields that have emerged in the last 50 years. Early notions of SES can be found within the realm of ecology and natural resource management in the Global North (Holling 1973; Odum 1953, 1973; Berkes and Folke 1998). Only more recently has an explicit SES approach get visibility in Latin America (e.g., Delgado and Marín 2005; Maass et al. 2010; Castro-Díaz 2017; Easdale et al. 2016). While TD came into its own in the 2000s, its roots could be found in the 1970s (and even earlier to the 1950s) with different efforts at local economic development in Europe and Latin America. Also beginning in the 1970s, PE consolidated in Europe and North America, becoming firmly established in the 1990s (Martínez Alier 2005). By the 2000s, though, PE also came to have globally influential scholars from Latin America, where authors like Colombian A. Escobar (2000), Mexican E. Leff (2004), and Argentine H. Alimonda (2004) began to work with this perspective on local problems, such as peasant and indigenous social movements and environmental conflicts in defense of natural resources (land, water, mining).

Regarding their objects/subjects of study, SES uses systems-thinking and complexity and networking theories to attempt to study the whole. For its part, although TD began with a focus on economics, it has since expanded to a more encompassing

Table 1 Summary of analytical axes for the conceptualization of perspectives in socio-ecological topics for Latin America

Analytical axes	Characteristics	Political ecology	Territorial development	Socio-ecological systems
History	<i>Origins (temporal and spatial)</i>	1970s in Global North; 1990s in Latin America	1980s in Global North and Latin America	Beginning in the 1970s and consolidating in the 1990s in Global North; 2000s in Latin America
	<i>Key figures and institutions (countries)</i>	Martínez Alier (Spain), Alimonda (Argentina), Escobar (Colombia, USA), Leff (Mexico)	Albuquerque (Spain) Costamagna (Argentina), Instituto Praxis (Argentina)	Holling (Canada), Odum brothers (USA), Berkes (Netherlands, Canada), Folke (Sweden)
Epistemology	<i>Predominant research types and foci</i>	Basic, social science-based research, largely academic and theoretical Started with the “environmental crisis” and added political and power dimensions	Applied, social science-based analysis of local productive systems Started from an economic perspective, but moved toward holistic understanding	Basic, but often applied to real-world problems, natural science-based studies that often use complexity and network theories and resilience concepts Started as ecology integrating humans, but expanding to toward the social domain
	<i>Methods</i>	Qualitative	Increasingly participatory research action to co-construct knowledge(s)	Mixed, but primarily quantitative
	<i>Confirmation and validation</i>	Qualitative methods	Statistics are used, but also the putting into practice of information based on transferability, viability, and credibility. Data for decision-making	Uses statistics and modeling

(continued)

Table 1 (continued)

Analytical axes	Characteristics	Political ecology	Territorial development	Socio-ecological systems
	<i>Study object</i>	Process and dynamics of power that determine the distribution (access and benefits sharing) of natural resources	Productive processes/ microprocesses that lead toward improvement of quality of life of the people living in a territory	Feedback processes and thresholds or parts of the system
Metaphysics	<i>Objectivity</i>	Assumes subjectivity	Assumes subjectivity and the co-construction with stakeholders. It criticizes supposed objectivity in science and territorial construction. It assumes subjectivity from the political posture that conditions processes being studied	Tends toward objectivity
	<i>Reductionism versus holism</i>	Emergent approach	Emergent approach	Systems approach that recognizes both holism and reductionism
	<i>Conceptualization of nature</i>	Nature as an element of power and dispute between social actors	Nature is part of the “scenario” of the territory, but not central to it. Nature is mostly conceived of as natural resources for production. In recent years, the perspective of “sustainable development” gave nature a greater role, but it continues to be one of various dimensions	Nature conditions social practices and should be reconciled with human uses. Nature is recognized as being a source of benefits for humans and also the recipient of their actions (reciprocity)

understanding of human well-being and the needs to innovate in production systems to fulfill these needs. Meanwhile, PE looks more specifically at the political dimensions of natural resources, while not denying other elements. These foci condition these disciplines’ methodologies, for example, SES studies frequently concern system resilience with thresholds and feedbacks (Adger 2000; Cumming 2011;

Castro-Díaz 2013), which use quantitative methods from basic science disciplines that use statistics and models. TD also addresses systems, analyzing productive processes (or micro-processes) that tend to be applied to a specific territory (e.g., local food systems), but its experiences are systematized, and case studies are often used in a specific spatio-temporal context. Additionally, in TD, research-action techniques are often used, and validation is conducted by putting findings into practice via transferability, viability, and credibility with local stakeholders (e.g., the Argentine city of Rafaela, see also Karlsen and Larrea 2015). Finally, PE is mostly concerned with basic research and uses qualitative methods that are not always subject to statistical validation techniques. Some PE studies, though, concern such topics as environmental justice and use participatory approaches, like TD, to not only study but transform or affect reality (e.g., avoid conflicts related to natural resource industries, such as mining). However, in Latin America, most PE continues to be academic, but often related to social and environmental justice movements, and therefore also has an applied intention, even if not an applied approach. Indeed, throughout Latin America, PE observatories have arisen to maintain monitoring of these human-nature power conflicts (e.g., *Observatorio de Conflictos por Recursos Naturales*, <https://ocrn.info/>; *Observatorio Latinoamericano de Conflictos Ambientales*, <http://olca.cl/olca/index.htm>).

While each of these disciplines approaches human-nature relationships from different epistemological positions, histories, and interests in socio-scientific questions, they share many points in common, and these similarities and synergies provide ample space for collaboration and dialogue. Latin American social science traditions, such as TD and PE, have consolidated bodies of literature and knowledge communities and, therefore, should be further considered by natural scientists and interdisciplinary scholars as the new paradigm of SES is implemented. Many natural and applied scientists may have an inherent affinity to the SES approach, given its history and philosophical orientation (e.g., systems modeling and quantitative methods), but they should also be aware of these other traditions that have been developing from Latin America for several decades, and whose research production is often made in Spanish or in local and regional journals, which many not be part of the “global brain circulation” (sensu Anderson et al. 2015a).

Applying Ostrom’s SES Analytical Framework to Latin America

The SES analytical framework proposed by Ostrom (2007, 2009) considers social-ecological interactions at macro and micro levels (multilevel), from local to regional spatial scales (multi-scale), and applicable to specific case studies (Perevochtchikova 2018). It is an integrative framework developed from a bibliographic review of more than 40 years of different approaches and theories analyzing the relationship between society and ecosystems, adaptable to other theories and diverse SES. The framework takes up and integrates big groups of ecological variables, conceived of as resource systems and units, which include biodiversity and ecosystems, and

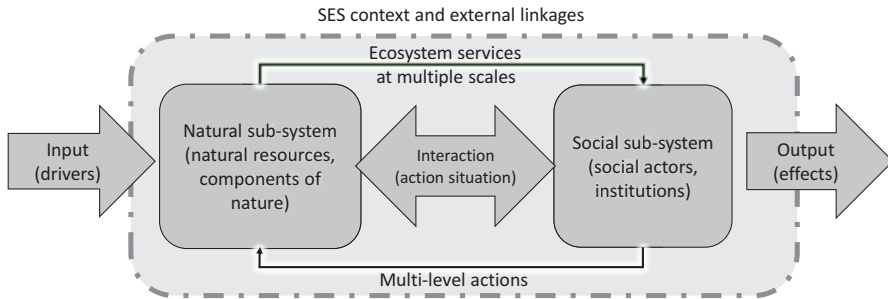


Fig. 1 Summary of Ostrom's (2007, 2009) framework for conceptualizing socio-ecological systems (SES)

social variables, considered of as governance systems and users, which encompass stakeholders and institutions. In turn, these sub-systems are interconnected through the action situation that has inputs (drivers) and leads to certain outputs (effects) on the operation processes of a hypothetical SES. Each SES has connections with other, external systems, and it has certain characteristics of the political, social, and economic context that is present at different territorial and temporal scales (Fig. 1).

After selecting the analytical framework for a specific study, which depends on objectives, goals, and resources, the next stage of formalization refers to the selection of variables that later allow to arrive at the filling and breakdown of information into each group and even to formulate indicators. These variables can be analyzed qualitatively or quantitatively, taking information from a documentary analysis of existing sources (official and academic) and/or constructing it from fieldwork. Each group of these variables is desegregated in corresponding levels, and interdisciplinary, inter-sectoral, and inter-institutional collaborations are required for integrated analysis (Perevochtchikova 2018).

A practical contribution in terms of formalizing the framework and presenting quantitative relationships can be found in Schlüter et al. (2014), which used a format of equations and mathematical language to model the case of a fisheries SES. Bennett and Gosnell (2015) pre-select some second-level variables from Ostrom's framework (2009) and adjust them to the needs and context of particular cases. Some interesting exercises can be highlighted as the adaptation of the general framework for forestry and fishing systems in Hinkel et al. (2014), and other case studies dealing with the process of formalizing the SES framework at a local scale and ranging from the conceptual determination to the definition (Hinkel et al. 2015).

In Latin America, there are still few examples of formalizing the SES framework and even less of its operationalization (Perevochtchikova 2018). Among the almost absent publications on the operationalization of the framework (which refers to the analysis of variables based on obtained information), the study by Leslie et al. (2015) developed a regional-scale analysis in several fishing communities from Baja California, Mexico, which was more focused on determining economic benefits related to different ways of fishing. However, these cases confirm that this SES analytical framework is adaptive to a variety of SES contexts and can be modified

to practically any study case, with better results at local or regional scales being integrative and considering the great potential for use in scientific research and public policy.

The majority of Latin American publications with a social science focus have objectives linked to the analysis of the relationship between human well-being, multilevel actions, and policy-making with multi-scale ecosystem services over time and space. For example, these studies seek to detect the effects of applying governmental conservation programs in Mexico (Perevochtchikova, 2019), to understand the well-being and the use of ecosystem services by rural households in Chile (Delgado and Marín 2016), to analyze the vulnerability of SES in Colombia (Berrouet et al. 2018), to determine livelihood strategies in complex SES in Nicaragua (Williams and Kramer 2019), and to study resilience and dynamic use of biodiversity in Costa Rica (Rodríguez and Davidson-Hunt 2018).

The social science works have explicitly incorporated historical analysis to reconstruct the trajectory of change of SES, with the use of geographical information systems (GIS) for space analysis of physical and biological variables and land use changes. On the other hand, it is very common to find interviews with key stakeholders and survey applications for governance studies. Also, ethnographic data collection is seen through participant observation, assisting different social actors' labors, and during fieldwork and workshops. Ethnoecological approaches also include transect walks and life story interviews. The analytical techniques found in these social studies combine the quantitative and qualitative approaches, but in each of these cases interdisciplinarity is a necessity, where social sciences and scientists can play a strong role for analysis of interactions, related to actors, institutions, and governance aspects ranging from inputs (e.g., public policy) to outputs (e.g., benefits) of SES.

4 Literature Review of SES Publications

Many proposals are being developed in the global scientific literature (1) to define SES (Haberl et al. 2006), (2) to operationalize models to study SES (Collins et al. 2011), (3) to apply SES knowledge to public policies and private decisions (Carpenter et al. 2009), and (4) to develop research and governance models that include diverse social actors (e.g., the Inter-Governmental Platform on Biodiversity and Ecosystem Services (IPBES): Díaz et al. 2015; Anderson et al. 2019). Anderson et al. (2015b) found an exponential growth in the use of SES-related terms in ecology and sustainability journals beginning in the 2000s. However, there is also an indication that the conceptualization of SES in this body of literature has been influenced mostly by quantitative social sciences (e.g., studies of institutions, economic incentives, land use, population, social networks, and social learning), with less emphasis on those approaches with interpretative tradition (Stojanovic et al. 2016).

We carried out a systematic literature review to identify, organize, and analyze the scientific production regarding the use of SES in the world and in Latin

America. The review was based on the proposal by Grant and Booth (2009), Booth et al. (2012), and Perevochtchikova et al. (2019). This review used standards and procedures established in the declaration of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al. 2009) and applied the Search, Appraisal, Synthesis, Analysis (SALSA) framework, which is shared by many studies that perform systematic reviews of scientific literature (Grant and Booth 2009; Codina 2015). Taking as a reference the search strategies used in ecosystem services literature reviews (Perevochtchikova and Oggioni 2014; Martinez-Harms et al. 2015; Ezzine-de-Blas et al. 2016; Locatelli et al. 2017; Himes-Cornell et al. 2018; Perevochtchikova et al. 2019), the decision was made to perform an advanced search in the Scopus database, which gathers information on publications of high scientific rigor at an international level.

The first phase of the analysis considered the construction of syntaxes with the use of keywords in English and Spanish linked to the concept of “socio-ecological systems.” The search for the selected terms was carried out in titles, abstracts, and keywords, and then we applied a filter to select only those publications in journals related to social sciences. In the second phase of evaluation, a sub-search focused on the geographic delimitation of SES studies referring to Latin America and/or to the countries of the region, also with a social science filter, to assess the importance of this focus for SES.

Globally, a total of 7300 records were obtained, of which 2198 were open access. Publications are mostly made in an article format (74.3%) and in English (99.8%); much fewer contributions to SES are published as reviews (9.4%), book chapters (6.9%), conference proceedings (4.2%), and books (1.1%). The earliest work appeared in 1970, and there has been an exponential growth since 2003, which closely correlates to the Millennium Ecosystem Assessment (MEA 2005), with more than 1000 publications in 2018.

Within this literature, the disciplinary approaches were diverse, and for the purposes of calculating percentages, one study could pertain to more than one research domain. Globally, interdisciplinary (i.e., environmental sciences, 55.7%), social science (37.5%), and agricultural and biological sciences (22.5%) approaches dominated. Lesser contributions came from medicine (13.8%), earth and planetary sciences (8.3%), physiology (6.3), and economics (7%).

Among the 158 countries involved in these publications, the dominant political entities were (in decreasing order) the USA, Australia, Canada, the United Kingdom, Germany, Switzerland, the Netherlands, France, and Spain. From Latin America, Brazil (in 14th place with 168 publications), Mexico (in 17th place with 137 publications), and Chile (in 20th place with 108 publications). Regarding study sites, the largest percentage were located in North America (15%), but 11% were from Latin America. This situation represents an opportunity to develop works on this subject in our region and potentially means that, despite the relatively low scientific production, Latin America has study areas that are of interest to the international community due to the high biological and cultural diversity.

For Latin America, a total of 556 publications (with 197 as open access) were found until April 2019. This constitutes only about 7.6% of the international SES

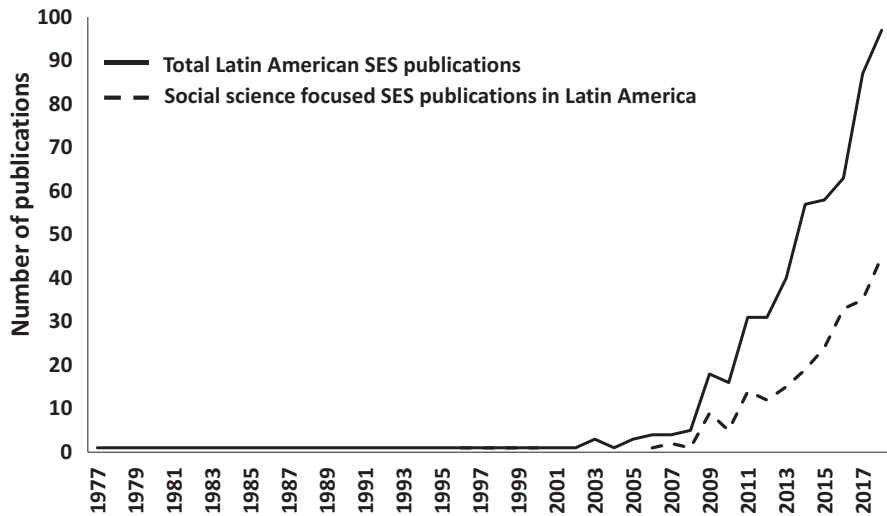


Fig. 2 Total number of socio-ecological (SES) publications in Latin America from the Scopus database (solid line) and those SES studies that had a specific social science orientation (dashed line)

research production. While globally the first publication was in 1970, in Latin America it was in 1977, and a growth trend is observed since 2006, increasing markedly since 2016 (Fig. 2). The sharp increase in Latin American SES research coincides with the publication of the works of importance and international reference in the topic of SES, such as MEA (2005) and especially other influential papers like McGinnis and Ostrom (2014), Schlüter et al. (2014), Hinkel et al. (2014), among others.

Almost 85% of the Latin American SES studies are published as scientific articles (with only 5% as book chapters, 4% as reviews, and 3% as conference papers). The research disciplinary domains are similar to the results found at an international level: environmental sciences (64%), social sciences (42%), agricultural and biological sciences (32%), earth and planetary sciences (9.5%), medicine (6.7%), economics (5.9%), energy (4.9%), arts and humanities (4.7%), and engineering (4.1%). While the social sciences are found at second place in both the global and regional scales, Latin American also had SES studies published in arts and humanities journals.

Among the 71 countries mentioned in the Latin American SES publications, the following trends were observed for their contribution to overall research productivity: USA (38%), Brazil (17%), Mexico (15%), Chile (11%), UK (10%), Canada (10%), among other countries in Europe, Latin America, also New Zealand and China, and even with a few works from Morocco and the Russian Federation. Regarding the affiliation of the corresponding authors of the publications, we found the greatest representation from academic institutions in Brazil, Mexico, and Chile, followed by Argentina, Colombia, Ecuador, and Peru. Also, financial support

for these projects mainly came from national science and technology commissions of the mentioned countries, and then also from different entities and agencies in the USA.

Focusing explicitly on Latin American SES studies that were undertaken with a social science orientation, a total of 235 publications were found (60 as open access). Among these publications, articles clearly dominate (87%), followed by book chapters (4.3%) and reviews (3.4%). The publications are also made in international journals, which are predominantly in English and use the ISI Impact Factor. *Interciencia* is the only Spanish language journal that was found among the list of the top ten sources of Latin American SES articles. This journal has also provided space to present theoretical-conceptual discussions and case studies, which many international journals are reticent to accept.

Among the 51 countries mentioned in these publications, most of the studies came from the USA, Brazil, Chile, Mexico, Canada, the UK, the Netherlands, Germany, Spain, Argentina, and Colombia (Fig. 3). The same trend was found regarding the affiliation of the corresponding author and with the sources of financial support. In this sense, among the funders, there are 159 sources mentioned in acknowledgments, including government agencies, international agencies, foundations, as well as national science and technology councils, or academic and national universities. Important support particularly comes from the USA, Mexico, Brazil, Canada, Germany, and the European Union. From Latin America, countries such as Mexico, Brazil, and Argentina resulted as the most important in support of SES research.

In general, Latin American SES studies consider case studies at local or regional scales, from multi- and, to a lesser extent, interdisciplinary perspectives with the use

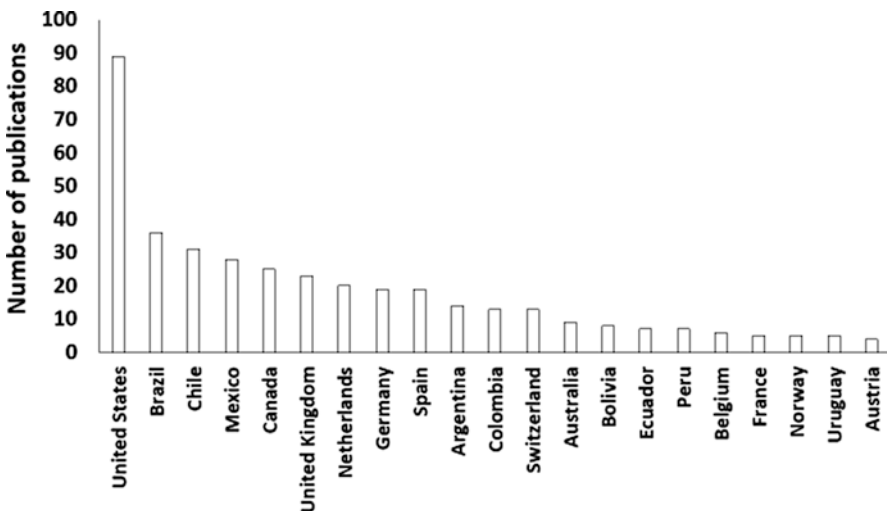


Fig. 3 Countries with the most research productivity in Scopus regarding Latin American socio-ecological publications with a social science orientation

of mixed or quantitative methods. The purposes of the studies include improvement of the human vulnerability and adaptability to external stressors (e.g., climate change or other risk situations), improvement of mechanisms for public management of natural resources (e.g., incorporating integrated vision into the proposals), or improvement in productive systems (e.g., agroforestry). Among the challenges that remain to be addressed, we can mention areas of opportunity in the development of practices: interdisciplinary analysis (with not only the construction of physical models of ecological functioning or conceptual models of interaction between social-ecological variables); transdisciplinary studies (from different sectors of society); impulse to modeling (e.g., based on dynamic systems); and even application of techniques such as social networks.

5 Final Reflections

Latin America has much to offer the world regarding the human dimensions of SES, given our high cultural and ecological diversity (IPBES 2018b). In addition, a pantheon of important social and environmental scholars come from Latin America, including social ecology in Uruguay (Gudynas and Evia 1991); environmental sociology in Argentina (Svampa 2008), the implications of political and social movements in the face of intense economic production during armed conflict in Colombia (Escobar 2000), ecological economics that questions orthodoxy by questioning underlying rationalities of modernity, based on such pillars as technology, monetary cost-benefit analyses, and science in Mexico (Leff 2010) and the need to consider the human-face of development in Chile (Max-Neef 1994). However, promoting knowledge dialogue between disciplines is inherently difficult, and even more so when much of this SES-related scientific production has been made in regional journals or in Spanish.

Therefore, we should take into account intrinsic factors that have limited social science contribution of Latin America to the global debate in SES. For example, in many cases, these disciplines are still young with less than 20 years of development in post-dictatorial societies. At the same time, there are external relationships that condition local dynamics, such as North/South power dynamics that are inherent in the “global brain circulation” (Anderson et al. 2015a). Here, though, we find hope that knowledge dialogue can be improved between North/South and disciplines, which is evidenced in experiences such as the Inter-Governmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), that is working to bring to light these previously underrepresented voices in the assessment and governance of SES.

In this chapter, we have taken a social science perspective to SES and human-nature relationships, which has identified and legitimized the study of social variables beyond merely economic considerations (Anderson et al. 2019). The depth and breadth of these contributions is only clear, however, if SES researchers and practitioners take the time to learn the history of these traditions in our continent

and also make the effort to understand how to dialogue with these complementary and sometimes contradictory proposals, which requires understanding not only the history but also the philosophical underpinnings of our and other's disciplines. The "disciplinary" perspectives of the environment without question can be integrated into an interdisciplinary approach, but it is important to recognize how humans are being conceived of as part of nature (e.g., defending it, destroying it, using it, and living in it). All of these approaches can advance the study of processes related to society-nature, but it is important to distinguish different elements to then be able to integrate and articulate those concepts and knowledge(s). The ongoing challenge to attain mutual recognition among these fields and improve dialogue (or triologue: territorial development and political ecology) can be aided by finding complementary perspectives that provide different tool sets to more fully address the complexity of socio-ecological study topics.

To date, the historical and current contributions that Latin American social science and humanist traditions have made to SES research have been limited, but there are reasons to hope that it is possible to improve this deficit. On the one hand, clearly, these academic traditions are advancing. Therefore, it would be important for them to become self-aware and strategic to engage in the global debate. Latin American countries are contributing strongly to the conceptual framework and operationalization of such initiatives as IPBES (Díaz et al. 2015; IPBES 2018b; Anderson et al. 2019), including the recognition and incorporation of diverse knowledge sources(s) into decision-making. Also the Latin American Social Sciences Council (*CLACSO*) develops many efforts for support existing research networks by its Work Team Program, including a Network for Transdisciplinary Studies of Ecosystems and Society (*Red de Estudios transDisciplinarios sobre el Ecosistema y la Sociedad*), which involves social scientists throughout Latin America striving to understand the complexity beyond the territories in the region. Finally, further engagement in these efforts by social scientists from Latin America is one way to take their voice (including ideas, concepts, methods, and paradigms) into a global platform that empowers and seeks to integrate plural values and perspectives, augmenting participation through publications and helping integrate the social science into solving real-world problems.

References

- Adger WN (2000) Social and ecological resilience: are they related? *Progr Hum Geogr* 24(3):347–364
- Alimonda H (2004) Una introducción a la Ecología Política latinoamericana (pasando por la historia ambiental). Documento curso de posgrado en Ciencias Sociales (Universidad Federal Rio de Janeiro)
- Anderson CB, Monjeau A, Rau J (2015a) Knowledge dialogue to attain global scientific excellence and broader social relevance. *Bioscience* 65:709–717
- Anderson CB, Pizarro JC, Estevez R et al (2015b) ¿Estamos avanzando hacía una socio-ecología? Reflexiones sobre la integración de las dimensiones "humanas" en la ecología en el sur de América. *Ecol Austral* 25:263–272

- Anderson CB, Seixas CS, Barbosa O et al (2019) Determining nature's contributions to achieve the sustainable development goals. *Sust Sci* 14:543–547
- Avila-Foucat VS, Perevochtchikova M (eds) (2018) *Sistemas socio-ecológicos: marcos analíticos y estudios de caso en Oaxaca, México*
- Bennett DE, Gosnell H (2015) Integrating multiple perspectives on payments for ecosystem services through a social–ecological systems framework. *Ecol Econ* 116:172–181
- Berkes F, Folke C (1998) *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge University Press, Cambridge
- Berrouet LM, Machado J, Villegas-Palacio C (2018) Vulnerability of socio—Ecological systems: a conceptual framework. *Ecol Indic* 84:632–647
- Booth TH, Williams KJ, Belbin L (2012) Developing biodiverse plantings suitable for changing climatic conditions 2: using the Atlas of Living Australia. *Ecol Manage Restor* 13(3):274–281
- Carpenter SR, Mooney HA, Agard J et al (2009) Science for managing ecosystem services: beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academies of Science of the United States of America* 106:1305–1312
- Castro-Díaz R (2013) Implicancias de la resiliencia espacial en la prestación de servicios ambientales en cuencas norandinas. *Contribuciones Científicas. GAEA* 25:71–87
- Castro-Díaz R (2014) Implicancias territoriales de los esquemas de pago por servicios ambientales (PSA) en cuencas norandinas. *Cuadernos de Geografía-Revista Colombiana de Geografía* 23(1):61–74
- Castro-Díaz R (2017) Epistemología y pragmatismo en el análisis de los sistemas complejos. *Revista Latinoamericana de Metodología de las Ciencias Sociales* 7(2):e026. <https://doi.org/10.24215/18537863e026>. Accessed 8 June 2019
- Castro-Díaz R, Natenzon CE (2018a) The social vulnerability and ecosystem services feedback: approaching social-ecological analysis in water supply for Andean communities. *World Social Science Forum “Security and Equality for Sustainable Futures”*, Fukuoka
- Castro-Díaz R, Natenzon CE (2018b) Análisis de las transformaciones espaciales del suelo y sus implicancias para la provisión de agua en la Laguna de Fúquene, Colombia. In: Díaz I (ed) *Servicios Ecosistémicos en Humedales*. SEDEMA, Veracruz, pp 181–217
- Codina L (2015) No lo llame Análisis Bibliográfico, llámelo Revisión Sistemática. Y cómo llevarla a cabo con garantías: Systematized Reviews + SALSA Framework. <https://www.lluiscodina.com/revison-sistemata-salsa-framework>. Accessed 8 Jun 2019
- Collins SL, Carpenter SR, Swinton SM et al (2011) An integrated conceptual framework for long-term social–ecological research. *Front Ecol Environ* 9:351–357
- Cumming GS (2011) Conceptual background on social-ecological systems and resilience. In: Cumming GS (ed) *Spatial resilience in social-ecological systems*. Springer, Dordrecht, pp 7–33
- De Sousa Santos B (2006) La sociología de las ausencias y la sociología de las emergencias: para una ecología de saberes. In: De Sousa Santos B (ed) *Renovar la teoría crítica y reinventar la emancipación social (encuentros en Buenos Aires)*. CLACSO, Buenos Aires, pp 13–41
- Delgado LE, Marín VH (2005) FES-sistema: un concepto para la incorporación de las sociedades humanas en el análisis medioambiental en Chile. *Revista Ambiente y Desarrollo* 21(3):18–22
- Delgado LE, Marín VH (2016) Well-being and the use of ecosystem services by rural households of the Río Cruces watershed, southern Chile. *Ecosyst Serv* 21:81–91
- Díaz S, Demissew S, Carabias J et al (2015) The IPBES conceptual framework: connecting nature and people. *Curr Opin Environ Sustain* 14:1–16
- Easdale MH, Aguiar MR, Paz R (2016) A social–ecological network analysis of Argentinean Andes transhumant pastoralism. *Reg Environ Change* 6:2243–2252
- Ehrlich PR (1975) *The population bomb*. Rivercity Press, Rivercity
- Escobar A (2000) El lugar de la naturaleza y la naturaleza del lugar: ¿globalización o postdesarrollo? In: Lander E (ed) *La colonialidad del saber: eurocentrismo y ciencias sociales. Perspectivas latinoamericanas*. Editorial Consejo Latinoamericano de Ciencias Sociales, Buenos Aires, pp 68–87
- Estenssoro JF (2007) Antecedentes para una historia del debate político en torno al medio ambiente: la primera socialización de la idea de crisis ambiental. *Rev Universum* 22:92–111

- Ezzine-de-Blas D, Wunder S, Ruiz-Pérez M et al (2016) Global patterns in the implementation of payments for environmental services. *PLoS One* 11(3):e0149847
- Farah S (2012) Los sistemas socioecológicos. Una aproximación conceptual y metodológica. XIII Jornadas de Economía Crítica, España
- Folke C, Han T, Olsson P et al (2005) Adaptive governance of social-ecological systems. *Annu Rev Env Resour* 30:441–473
- Gallopin GC (2004) El Modelo Mundial Latinoamericano (“Modelo Bariloche”): Tres décadas atrás. In: Herrera AO, Sconick HD, Chichilnisky G et al (eds) *¿Catastrofe o Nueva Sociedad? Modelo Mundial Latinoamericano*. Centro Internacional de Investigaciones para el Desarrollo, Ottawa, pp 13–26
- García R (2006) Sistemas complejos: conceptos, métodos y fundamentación epistemológica de la investigación interdisciplinaria. Ed. GEDISA, Barcelona
- Goñi R, Goin F (2006) Marco Conceptual para la Definición del Desarrollo Sustentable. *Salud Colectiva* 2(2):191–198
- Grant MJ, Booth A (2009) A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J* 26:91–108
- Gudynas E, Evia G (1991) *La Praxis por la Vida—Introducción a las metodologías de la Ecología Social*. CIPFE—CLAES—NORDAN, Montevideo
- Haberl H, Winiwarter V, Andersson K et al (2006) From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research. *Ecol Soc* 11(2):13. <http://www.ecologyandsociety.org/vol11/iss2/art13/>. Accessed 8 Jun 2019
- Herrera AO, Sconick HD, Chichilnisky G et al (eds) (2004) *¿Catastrofe o Nueva Sociedad? Modelo Mundial Latinoamericano: 30 años después*, 2nd edn. Centro Internacional de Investigaciones para el Desarrollo, Ottawa
- Himes-Cornell A, Pendleton L, Atiyah P (2018) Valuing ecosystem services from blue forests: a systematic review of the valuation of salt marshes, sea grass beds and mangrove forests. *Ecosyst Serv* 30:36–48
- Hinkel J, Bots PWG, Schlüter M (2014) Enhancing the Ostrom social-ecological system framework through formalization. *Ecol Soc* 19(3):51
- Hinkel J, Cox ME, Schlüter M et al (2015) A diagnostic procedure for applying the social-ecological systems framework in diverse cases. *Ecol Soc* 20(1):32
- Holling CS (1973) Resilience and stability of ecological systems. *Annu Rev Ecol Syst* 4:1–23
- IPBES (2018a) Summary for Policymakers of the Assessment report on Land Degradation and Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn
- IPBES (2018b) Summary for Policymakers of the Assessment Report on the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on Regional Assessment for the Americas. Secretariat of the Intergovernmental Science-Platform on Biodiversity and Ecosystem Services, Bonn
- IPCC (2018) Summary for policymakers. In: Masson-Delmotte V, Zhai P, Pörtner HO et al (eds) *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. World Meteorological Organization, Geneva, p 1–24
- Karlsen J, Larrea M (2015) Desarrollo territorial e investigación acción. Innovación a través del dialogo. Instituto Vasco de competitividad, Serie Desarrollo territorial. Universidad de Deusto
- Koch A, Brierley C, Maslin MM et al (2019) Earth system impacts of the European arrival and Great Dying in the Americas after 1492. *Quater Sci Rev* 207:13–36
- Kuhn T (1962) *The Structure of Scientific Revolutions*. The University of Chicago, Chicago
- Leff E (2004) *Racionalidad Ambiental. La Reapropiación Social de la Naturaleza*. Ed. Siglo XXI, Mexico
- Leff E (2010) Economía ecológica, racionalidad y sustentabilidad. *Sustentabilidades* 2:106–119
- Leslie HM, Basurto X, Nenadovic M et al (2015) Operationalizing the social-ecological systems framework to assess sustainability. *PNAS* 112(19):5979–5984

- Lira-Noriega A, Soberón J (2015) The relationship among biodiversity, governance, wealth, and scientific capacity at a country level: disaggregation and prioritization. *Ambio* 44(5):391–400
- Locatelli B, Aldunce P, Fallot A et al (2017) Research on climate change policies and rural development in Latin America: scope and gaps. *Sustainability* 9(10):1831. <http://www.mdpi.com/2071-1050/9/10/1831>. Accessed 8 Jun 2019
- Maass M, Díaz-Delgado R, Balvanera P et al (2010) Redes de Investigación Ecológica y Socio-Ecológica a Largo Plazo (LTER y LTSER) en Iberoamérica: Los casos de México y España. *Revista Chilena de Historia Natural* 83(1):171–184
- Martínez Alier J (2005) El Ecologismo de los Pobres. *Conflictos Ambientales y Lenguajes de Valoración*. Icaria, Barcelona
- Martinez-Harms MJ, Bryan A, Balvanera P et al (2015) Making decisions for managing ecosystem services. *Biol Conserv* 184:229–238
- Max-Neef MA (1994) *Desarrollo a Escala Humana: Conceptos, Aplicaciones y Algunas Reflexiones*. Icaria Editorial SA, Barcelona
- McGinnis MD, Ostrom E (2014) Social-ecological system framework: initial changes and continuing challenges. *Ecol Soc* 19(2):30
- MEA (2005) *Ecosystems and human well-being: scenarios*. Island Press, Washington, DC
- Meadows DH, Meadows DL, Randers J et al (1972) *The limits to growth: a report for the club of Rome's project on the predicament of mankind*. Universe Books, New York
- Merçon J, Ayala-Orozco B, Rosell JA (2018) *Experiencias de colaboración transdisciplinaria para la sustentabilidad: Construyendo lo común*. CopIt-arXives, México
- Moher D, Liberati A, Tetzlaff J et al (2009) Preferred reporting items for systematic reviews and meta analyses: the PRISMA statement. *PLoS Med* 6(7):e1000097. <https://doi.org/10.1371/journal.pmed1000097>
- Morin E (2009) *Introducción al pensamiento complejo*. Gedisa, México
- Nisbet EK, Zelenski JM, Murphy SA (2009) The nature relatedness scale: linking individuals' connection with nature to environmental concern and behavior. *Environ Behav* 41(5):715–740
- Odum EP (1953) *Fundamentals of ecology*, 2nd edn. W. B. Saunders, Philadelphia
- Odum HT (1973) Energy, ecology and economics. *Ambio* 2:220–227
- Ostrom E (2007) A diagnostic approach for going beyond panaceas. *Proc Natl Acad Sci U S A* 104:15181–15187
- Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. *Science* 325:419–422
- Pahl-Wostl C, Kranz N (2010) Editorial to special issue: water governance in times of change. *Environ Sci Policy* 13:567–570
- Pahl-Wostl C, Holtz G, Kastens B et al (2010) Analyzing complex water governance regimes: the management and transition framework. *Environ Sci Policy* 13:571–581
- Perevochtchikova M (2016) *Estudio de los efectos del Programa de Pago por Servicios Ambientales: Experiencia en Ajusco, México*. Editorial El Colegio de México, México
- Perevochtchikova M (2018) Formalización de un sistema socio-ecológico forestal mexicano. In: Ávila Foucat VS, Perevochtchikova M (eds) *Sistemas socio-ecológicos: marcos analíticos y estudios de caso en Oaxaca, México*. IIc-UNAM, México, pp 129–146
- Perevochtchikova M, Oggioni J (2014) Global and Mexican analytical review of the state of art on ecosystem and environmental services: a geographical approach. *Investig Geogr* 85:47–65
- Perevochtchikova M, De la Mora G, Hernández Flores JA et al (2019) Systematic review of integrated studies on functional and thematic ecosystem services in Latin America, 1992–2017. *Ecosyst Serv* 36:1–13. <https://doi.org/10.1016/j.ecoser.2019.100900>. Accessed 9 June 2019
- Pillet F (2004) La geografía y las distintas acepciones del espacio geográfico. *Investig Geogr* 34:141–154
- Postigo JC, Blanco Wells G, Chacón Cancino P (2013) Las ciencias sociales en la encrucijada: el cambio ambiental global en América Latina y el Caribe. In: *Informe mundial sobre ciencias sociales, 2013: cambios ambientales globales*. UNESCO, Paris, pp 166–177
- Roberts RG, Flannery TF, Ayliffe LK et al (2001) New ages for the last Australian megafauna: continent-wide extinction about 46,000 years ago. *Science* 292(5523):1888–1892

- Rodríguez M, Davidson-Hunt IJ (2018) Resilience and the dynamic use of biodiversity in a Bribri Community of Costa Rica. *Hum Ecol* 46(6):923–931
- Schlüter M, Hinkel J, Bots PWG et al (2014) Application of the SES framework for model-based analysis of the dynamics of social-ecological systems. *Ecol Soc* 19(1):36
- Scholz RW, Binder CR (2003) The paradigm of human-environment systems. Working Paper 37. Natural and Social Science Interface. Swiss Federal Institute of Technology, Zürich
- Scholz RW, Binder CR (2004) Principles of human-environment systems research. In: Pahl C, Schmidt S, Jakeman T (eds) *iEMSs 2004 International Congress: Complexity and Integrated Resources Management*. International Environmental Modelling and Software Society, Osnabrueck, pp 791–796
- Stojanovic T, McNae H, Tett P et al (2016) The “social” aspect of social-ecological systems: a critique of analytical frameworks and findings from a multisite study of coastal sustainability. *Ecol Soc* 21(3):15. <https://doi.org/10.5751/ES-08633-210315>
- Svampa M (2008) La disputa por el desarrollo: territorio, movimientos de carácter socio-ambiental y discursos dominantes. In: Svampa M (ed) *Cambio de época. Movimientos sociales y poder político*. Siglo XXI, Buenos Aires, pp 1–31
- Thomas JA, Telfer MG, Roy DB et al (2004) Comparative losses of British butterflies, birds, and plants and the global extinction crisis. *Science* 303(5665):1879–1881
- Weart SR (2008) *The discovery of global warming*. Harvard University Press, Harvard
- Williams NE, Kramer DB (2019) Agricultural biodiversity maintenance in a coastal socio-ecological system: the pearl lagoon basin, Nicaragua. *Hum Ecol* 47(1):111–120