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Socioecological conflicts in Mexico: Trends and gaps in the regional analysis

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ABSTRACT

Global economic growth and the problems generated by climate change will cause an increase in the occurrence and violence of socioecological conflicts in the coming decades. To understand these trends, it is important to determine the current state of the conflicts. In Mexico efforts have been made to analyze socioecological conflicts at the regional level. However, it is important to know the conceptual approach under which this has been addressed and what variables that reflect the complexity of its socio-ecological context have been considered. The objective of this article is to review the trends and information gaps in the regional analysis of socio-ecological conflicts in Mexico, using a systematic review of documentary information sources and geovisualizers. As a result, only 30.6% of the information sources feature a defined conceptual approach. The conflicts are characterized by the drivers and social or environmental impacts in all studies. On the other hand, information gaps include the elucidation of management alternatives (41.7%) and future scenarios (22.2%), the description (25%) and analysis of the implied ecosystem services (13.9%), a gender approach (16.7%), an analysis of the normative frame (8.3%), and the exogenous conditions associated with environmental patterns (38.9%) such as the influence of climate change. We argue that a regional analysis of conflicts using a socioecological approach integrating environmental and social components could allow a comparative analysis. It could also provide an understanding of the contextual variables and underlying causes of conflicts. This information is necessary for socioecological conflict management towards peaceful resolutions.

1. Introduction

Society forms part of and has evolved within nature. Over time, multiple interactions between humans and nature have enabled society to satisfy its needs for food, health, housing, and culture (Folke et al., 2016). However, there is a crisis regarding the relationship between society and environment, in which logic of extraction and uncontrolled consumption predominates. Consequently, there are considerable

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inequalities in the access to and control of natural resources (Pichler, 2016). The planetary impacts of this model of production-consumption have given rise to the Anthropocene (Crutzen, 2002). The latter has triggered different processes of degradation and socioecological conflicts worldwide (Robbins, 2012) .

Socioecological conflicts (SEC) are a manifestation of this global crisis. They develop within a dynamic and complex network of interactions that involves socio-cultural, environmental, and political factors that vary both spatially and temporally (Pichler and Brad, 2016; Rocheleau and Roth, 2007) . We define SEC as those conflicts that are manifested as a consequence of social inequalities associated with the use and conservation of natural resources (Martínez-Alier, 2004; Temper et al., 2018). The latter may imply confrontations over actions related to the scarcity, distribution, deterioration, or privation of nature and the benefits obtained from it, at least between two actors within a specific spatio-temporal context (Rincón-Ruiz et al., 2019; Pérez-Rincón et al., 2019).

SEC have occurred throughout history as a manifestation of the complexities of territories (Guerrero, 1999). However, in recent times and given an increasingly interconnected world (Liu et al., 2013), many of these conflicts have become stronger, giving rise to unexpected results. The recognition of SEC with an analysis of its territorial dynamics can provide statistics aiding in the understanding of trends (Tetreault et al., 2012). Their study can contribute to searching for management alternatives, finding solutions, and minimizing or even avoiding a violent confrontation (Sanchéz Vazquez and Eguiguren, 2017). Thus, the recognition and management of SECs can give rise to the transformation, growth, and development of society (Guerrero, 1999).

Conflict analysis demands the use of conceptual approaches that can reconcile social and natural spheres since environmental management requires an integral focus that recognizes the multiple elements and their interactions (Resilience Alliance, 2010). Various approaches have been used to address SEC. The scarcity - environmental deterioration - violence frame applies the premise that environmental deterioration leads to a detriment in natural resources causing social confrontation (Homer-Dixon, 1994). The institutional approach (Aguilar, 2003), centers in the processes of decision-making, negotiation, and construction of norms for addressing conflicts. Political ecology focuses on recognizing the socio-natural character of resources, broadening the spectrum of actors, offering a historical perspective, and relating conflicts to the wider processes of material transformation and unequal distribution of power. That approach allows for an understanding of how and who distributes, controls, uses, and benefits from resources and who assumes the environmental costs (Martinez-Alier et al., 2010; Le Billon, 2015). This approach has been linked to the environmental justice movement that addresses the struggle to achieve fair environmental distribution among people and between human and non-human interests, a perspective that has nourish academic analysis (Holifield, 2015).

On the other hand, an analysis framework that is increasingly being used for studying the interactions between society and nature is the socioecological systems (SES) framework. The SES refers to a system that considers biological and social subsystems in mutual interaction (González et al., 2008; Harrington et al., 2010). McGinnis and Ostrom (2014) conceptualize SES using four components: (1) resource systems, (2) resource units, (3) actors, and (4) governance systems, which are in turn influenced by exogenous conditions. At the center are the action situations that refer to the factors or inputs that unlock specific interactions among the different components described above. Action situations give rise to dynamic situations that can produce changes in each of the categories of the system.

Mexico is a country that holds an enormous biological and cultural diversity. However, it also has pronounced social inequalities (Adams et al., 2008; López-Feldman et al., 2011; López-Feldman and Rivera, 2018). An overexploitation of natural resources promoted mainly by the interests of the private sector, together with national policies, has caused an increase in environmental deterioration. This situation has given rise to different experiences of resistance and defense of territories of indigenous and campesino communities (Toledo et al., 2013; Poma and Gravante, 2018). Many of these SECs remain ongoing, and there is evidence that they have multiplied over the last two decades (Tetreault et al., 2012; Paz, 2017). The efforts that have been made to characterize and analyze these conflicts on a regional scale (Tetreault et al., 2012; Toledo et al., 2013) are still incipient and do not cover all the regions in the country. Moreover, there are no reports of studies regarding the conceptual approaches under which these efforts have been addressed, nor of the extent to which socioecological variables have been considered to address their complexity.

The objective of the present study is therefore to analyze the trends and gaps in the analysis and characterization of SEC in Mexico at the regional level. This is achieved through a review of documentary sources, including published literature and geovisualizers. The specific questions addressed were 1) what conceptual approaches have been used to address socioecological conflicts in Mexico? and 2) what variables of the socioecological systems have been considered? This study contributes valuable information regarding the state of knowledge of SEC in Mexico. For analysis and comparison, we used the SES framework of McGinnis and Ostrom (2014).

2. Methodology

The systematic review and analysis regarding SEC studies at the regional level in Mexico was conducted in three stages:

1) Bibliographic survey. There were two sampling criteria: studies from the year 2000 onwards were selected when they included three or more conflicts in Mexico in their review or analysis. Case studies were excluded, as were comparative studies between two cases, given the interest in analyzing these efforts at a regional level. A total of 36 studies were included (Appendix A).

The identification of the studies included geovisualizers (web), publications (scientific articles and books) and grey literature (technical reports and theses) that report SEC in Mexico. This search was conducted in Spanish and English using a combination of the word conflict (conflict or disputa, in Spanish) combined with two words, one from the subsections “a” and one from subsection “b”:

a) Socioecológico (socioecological), socio-ecológico (socio-ecological), socioambiental (socioenvironmental), socio-ambiental (socio-environmental), minería (mining), agua (water), recurso hídrico (water resource), deforestación (deforestation), degradación (degradation, erosion), energía renovable (renewable energy), energía alternativa (alternative energy), turismo (tourism), desarrollos (development), megaproyectos (megaprojects), contaminación (pollution) and defensa del territorio (defense of the territory).
b) Caracterización (characterization), monitoreo (monitoring), mapeo (mapping), plataforma (platform), observatorio (observatory) and ciencia ciudadana (citizen science).

The search of the geovisualizers was conducted in Google and in the documents of the following documentary bases: Academia, Annual Reviews, university digital libraries (El Colegio de la Frontera Sur, Universidad Autónoma de Yucatán, Universidad Nacional Autónoma de México), BioOne, Blackwell Publishing, Cambridge University Press, Consorcio Nacional de Recursos de Información Científica y Tecnológica, Directory of Open Access Journals, Elsevier, Google scholar, Network of Scientific Journals from Latin America and the Caribbean, Spain and Portugal, Oxford University Press, Repositorio Nacional del Gobierno de México, ResearchGate, SAGE, Scientific Electronic Library Online, Springer, Taylor & Francis Group and the Wiley Online Library.

2) Variables use for analyzing the studies. We selected nineteen variables based on the SES framework (McGinnis and Ostrom, 2014), categorized into action situation, resource system and resources units, actors, governance, and exogenous conditions (Table 1). The selection of

Table 1
Operationalization of the framework of socioecological systems (SES) for the analysis of socioecological conflicts in Mexico. The variables were codified in binary form for the purposes of analysis.

Components of the SES	Variables selected	Definition of the variable	References
Action situation (the conflict)	Causes of the conflict	Describes the factors that originated the conflict (for example: the imposition of a megaproject, a specific public policy, unequal benefits from a particular resource, differences in the valuation of a resource, etc.)	Carranza et al. (2020);Scheidel et al. (2020); Temper et al. (2018)
	Social and environmental damage	Describes the damage generated by the conflict to specific resources and as perceived by different actors (for example: destruction, pollution, looting, deterioration, scarcity, invasion, eviction, etc.)	
	Mobilization	Describes the actions taken by the actors regarding the conflict	
	Alternatives of management and solution	Reports proposals for the management and solution of conflicts.	
	Future scenarios (long-term)	Describes the possible effects that will be derived in the future as a result of the conflict	
Resource system and resource units	Sector	Main properties of the ecosystem and territory, type of primary productive activity and description of the natural resources (biotic or abiotic) involved in the conflict	Hileman et al. (2015);Zhang et al. (2020)
	Characteristics of the affected resource	Describes the resources or sector affected (qualitatively and quantitatively)	
	Ecosystem services affected	Mention and description of the ecosystem services involved in the conflict	
Actors	Local	Mention of the people or population directly involved in the conflict (i.e., *ejidatarios*, *comuneros*, private landowners)	Barli et al. (2006); Saarikoski et al. (2013);Hileman et al. (2015); Zhang et al. (2020)
	Private	Informs about the organizations or businesses involved	
	Government	Federal, state or municipal governments involved	
	Non-governmental and civil society organizations	Mentions the civil society groups and non-governmental organizations involved.	
	Independent activists	External actors interested in one side of the conflict	
	Gender approach	The differentiated effects or interests between men and women	
Governance system	Organizations	Identifies the social organizations of formal and informal local actors.	Barli et al. (2006); Dubois and Zografos 2012;Hileman et al. (2015)
	Property rights	Mentions the land tenure involved	
	Rules and sanctions	Description of the formal and informal norms of the local actors	
Exogenous conditions	Social, economic, and political context	Describes external aspects involved that can explain the context of the conflict. For example, the position of the government, if there has been violence, a specific public policy that would imply a change in laws, norms, regulations, programs	Crespo Guerrero et al. 2019;Baeta et al. (2018)
	Environmental patterns	Refers to the current and future environmental context in which the conflict develops (for example: climatic change and degradation)	

Source:Adapted from McGinnis and Ostrom (2014).

variables was conducted with a qualitative approach through a variables' review included in different SEC's studies and discussions in the interinstitutional research seminar on socioecological systems of the Yucatán Peninsula, held by the authors of this study. The references on which the selection of the secondary variables was based are shown in Table 1.

Moreover, we included the following variables for the general description: the reference of the study, the organizations that supported the study, date of publication, period of analysis of conflicts, number of conflicts reported for Mexico, type of conflicts, location of the conflicts at state level, and conceptual approach (Appendix B).

3) Analysis of the information. Verification and validation of the information were conducted in four stages: (1) Two of the authors consolidated a database integrating the information of the 36 studies into the eight variables describing the general characteristics of the studies, as well as the 19 variables described above referring to the SES framework. (2) All authors verified and validated the information. (3) The first two authors validated and codified in binary form the variables to facilitate the comparative analysis, and (4) we used descriptive statistics to analyze the variables in the selected studies. Finally, to integrate the results, authors counted the number of variables considered by study, and the relationship of the five action situation variables with the 14 variables of the socioecological systems described before.

3. Results

3.1. General characteristics of the selected studies

Through the review we identified nine geovisualizers, 24 documents and three studies that had a visualizer and a document (Appendix A). These studies have been developed by national (66.7%) and international (22.2%) universities and research centers, followed by social and civil organizations and foundations (19.4%), and by governmental organizations (5.6%).

Most of the studies were published within the last ten years (Fig. 1) and concentrate on conflicts occurring in the last decade (86.1%). According to the classification of conflict types, 47% of the studies address multiple conflicts associated with diverse productive activities and resource management, including mining, waste management and renewable energy, among others. Predominant among the studies that focused on a single conflict type are those centered on mining activities (19%) and on water management (11%; Fig. 2). Aguascalientes, Querétaro, Tamaulipas and Tlaxcala are the states with the lowest number of reports regarding SEC (fewer than seven), while Estado de México had 16, Guerrero and Veracruz had 18, Puebla 19, and Chiapas and Oaxaca 21, and were the ones with the greatest number of reports (Fig. 3). Of all the studies considered, only 30.6% included a specific conceptual approach, political ecology being the predominant one.

3.2. Integrative assessment

Using the 19 variables considered valuable to describe socioecological conflicts, we estimated the distribution of the studies in four ranks of variables considered (Table 2). The average number of variables considered per study is 12 (minimum 7 and maximum 18), 61% of studies considered 12 or more variables and 4 studies (11%) considered between 16 and 18 variables.

In addition, Table 3 shows the percentage of studies integrating the five action situation variables with the 14 variables of the socioecological systems. Using a rating scale by color, red colors evidence the major gaps in the analysis of socioecological conflicts: ecosystem services perspective, characteristics of the natural resources, the role of activists, gender perspective, rules and sanctions, and climate patterns. On the contrary, green colors emphasize that the socioecological conflict description usually considers the sector (natural resource involved), local, private, governmental, and non-governmental actors, local organizations, and the socioeconomic and political drivers.

3.3. Action situation

The factors mentioned in the reviewed studies as generators of SEC were very diverse. Examples range from historical processes related to capitalism or the neoliberal model to determinants of the political context at different levels. The latter include aspects such as public policies, legislative changes, international accords or different dispositions that enable the agency of external actors in the local context. With regards to the conflict, social and environmental damages were represented by looting, human rights offences, criminalization, pollution, deterioration of resources, and limitations in the access to specific resources, among others.

Fig. 1. Proportion of studies that report socioecological conflicts in Mexico for three different time periods.

As a response to these situations, 88.9% of the studies report social mobilizations that range from artistic manifestations to civil protests and actions towards the defense of territories (Fig. 4). On the other hand, less than half of the studies (41.7%) present alternatives for managing or resolving the conflicts. In the studies that do refer to such alternatives, there is a prominent use of international accords and mechanisms for improving democracy or for negotiation. Finally, future scenarios derived from the conflict are only mentioned in 22.2% of the studies. In these future scenarios, accentuated crisis is anticipated, as a result of situations such as overexploitation of aquifers and increased migration, as examples.

3.4. Resource system and units

Most of the studies (83.7%) specify the resources affected by the SEC (Fig. 4). A total of 3.3% are focused on protected areas and 16.7% on hydric resources, while 16.7% consider the territory itself as the main resource affected, and 63.3% consider diverse resources in their analyses, with no emphasis placed on any single resource in particular. On the other hand, only 25% of the studies mention the characteristics of the resources affected, in which recognition is given mainly to rivers, wetlands, beaches, aquifers, forested and agricultural land, biocultural and indigenous territories, archaeological sites, urban parks and natural reserves. Hydric resources present the most detailed characterization. We identified five studies (13.9%) that mention ecosystem services implied in the SEC. However, these are only referred to in general terms, without defining or specifying them.

3.5. Actors

The studies of SEC analyzed identify the presence of different types of actors (Fig. 4). The most prominent are the private sector (94.4%), which are the businesses with specific productive objectives in the disputed territory, governmental (94.4%), integrated by the dependencies of the federal, state and municipal governments, and local actors (89.5%), who are the inhabitants of the territories in which the conflict takes place (usually campesinos or indigenous peoples or small landowners). To a lower extent, there are the civil society organizations (72.2%) and independent activists (36.1%). It is important to note that the studies do not explore the heterogeneity within these groups in detail, and only 17% of the studies make reference to the differentiated impact of the conflict to men and women.

3.6. Governance

With respect to the identification of social organizations, more than half of those documented (66.7%), mention the groups involved in the conflict and those that have arisen because of the conflicts (Fig. 4). Land tenure is specified in 58.3% of the studies as a factor associated with SEC. A third of the conflicts mentioned in the studies occur in sites with collective land tenure. This form of land tenure arose due to the Mexican revolution, which gave rise to the creation and recognition of social property (indigenous communities and *ejidos*) and was an important factor in the definition of the rural context of modern Mexico (Torres--Mazuera, 2015). It was found that only three studies describe elements related to the rules and sanctions associated with the SEC. They describe, for example, the agreements made in the *ejido* assemblies (spaces of collective local deliberation) in response to the SEC.

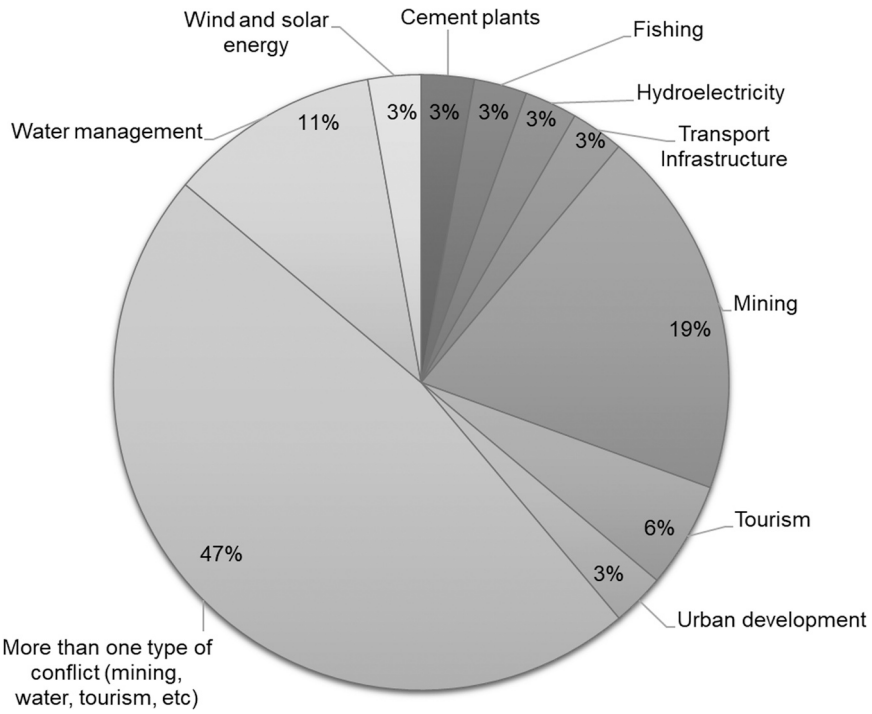

Fig. 2. Conflict types per economic activity and resource management included in the selected studies regarding socioecological conflicts in Mexico.

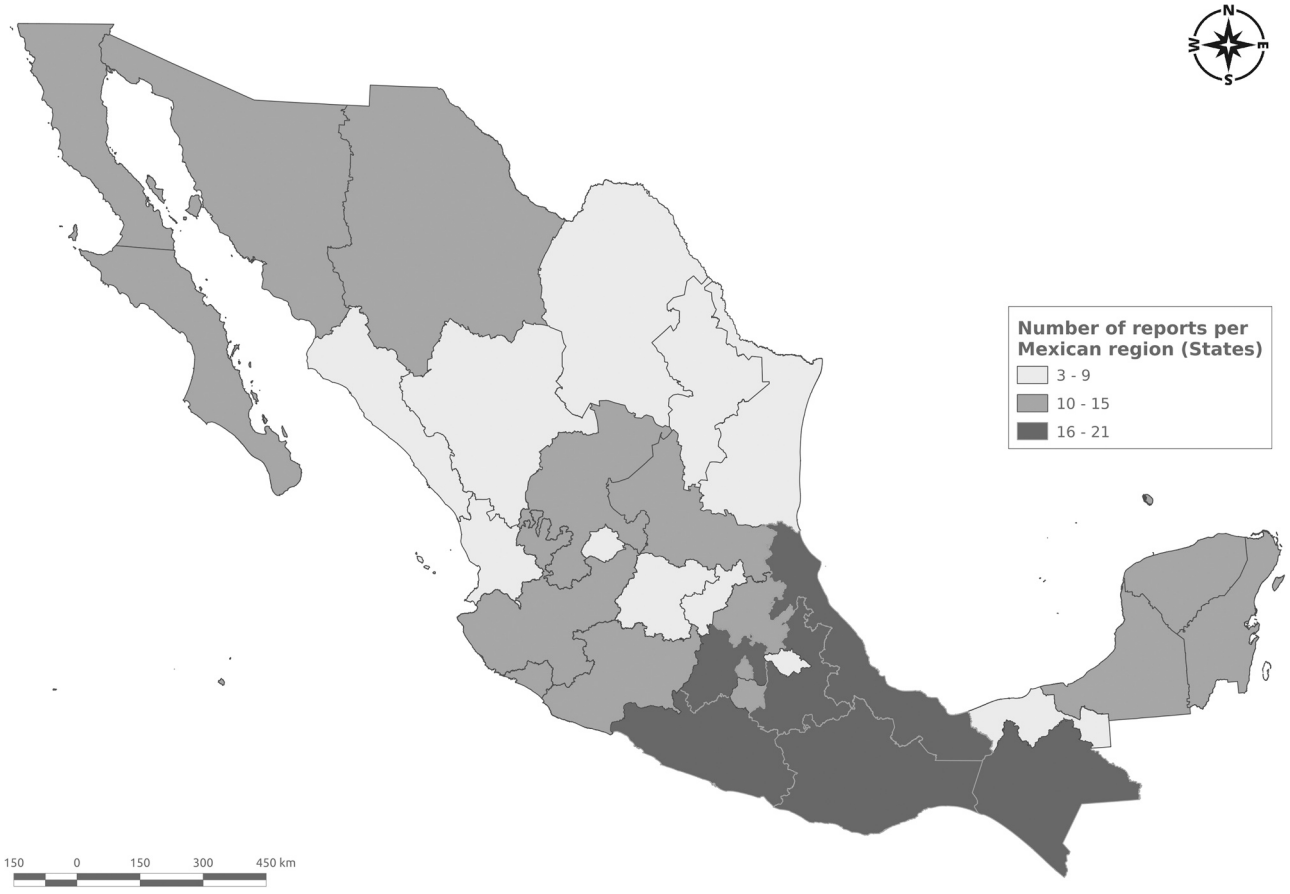

Fig. 3. Locations of the selected socioecological conflicts in Mexico reported in the selected sources and geovisualizers.

Table 2
Percentage of studies by the rank of variables.

Number of variables	Number of studies	Percentage of studies
<=8	1	2,8
9–11	13	36,1
12–15	18	50,0
16–19	4	11,1
Total	36	100

3.7. Exogenous conditions

Exogenous conditions, referring to the social, economic and political context, are addressed in 83.3% of the studies. There is prominent mention of the neoliberal economic model (Fig. 4). The expansion of the market economy is addressed in 30% of the studies, which indicates the growing demand for raw materials, energy, water and land, as well as the commodification of the economy. Laws, reforms or development plans are mentioned in 61% of the studies. There is frequent mention of the modification of article 27 of the Mexican Agrarian Law of 1992, which permitted privatization of collective lands. Also, there is mention of the International Convention 169, which refers to the prior consultation that must be conducted before the establishment of megaprojects (Appendix C).

Environmental patterns are mentioned in a general manner in 38.9% of the studies, making reference to environmental deterioration as a driver of conflict. On the other hand, climate change is analyzed in only one study (Rámirez et al., 2016), although the studies associated with megaprojects relate to energy highlight climate change as a justification for promoting the development of these projects (Appendix C).

4. Discussion

The review of the trends in the regional analysis of SEC with an integral conceptual framework (McGinnis and Ostrom, 2014), allows for the identification of important aspects that have not generally been considered, implying the challenges faced by this field of study. From 27 variables distributed in the categories of generalities, action situation, resources and unit systems, actors, governance, and exogenous conditions, we discuss the trends and information gaps in the studies reviewed, as well as the implications of incorporating the SES framework into our understanding of SEC.

The findings show that 86.1% of the studies analyzed for Mexico are from the last decade. Barli et al. (2006) and Martínez Alier (2007), also highlight a recent increase in the study of conflicts over natural resources and alternatives for their management and resolution. Analysis of the trends and gaps showed that 69.4% of the studies had not defined a conceptual approach. While each study offers elements for subsequent analysis, it is considered important to understand the implications of the absence of an explicit conceptual approach. Hileman et al. (2015) highlight that the analysis of SEC has focused on limited sets of biophysical and socio-political variables. Specifically, it focuses on the scarcity of the analysis of the natural resources implied, the institutions and the political and economic conditions, omitting an integral analysis of the context, which allows a structured and systematic understanding. The review conducted by these authors, which include 19 SEC associated with hydric resources in Central America, evidences the importance of variables such as location, limits, and size of the natural resource, as well as the rules of operation, rules of collective choice, constitutional rules, property rights, socio-economic attributes, social capital, norms, and history of use (Hileman et al., 2015). These variables were identified to a limited extent in the studies we reviewed. Moreover, (Reed et al., 2017) indicates the importance of considering the context that can either be enabling or constraining, facilitating, complicating, or even restricting the actions of certain actors, which determines interactions and triggers conflicts.

For their part, Hess and Fenrich, (2017) analyze alternatives in Brazil for the resolution of conflicts associated with the generation of energy through hydroelectricity and determine that the search for solutions requires addressing the underlying causes of the conflicts. Based on the SES framework, Zhang et al. (2020) analyzed the conflicts associated with the development of a natural reserve in three towns in China, finding that the SES framework allows for the identification of the diversity of contexts as well as the variations in the conflicts that are unleashed.

The review of the studies highlights the lack of an integral conceptual framework that allows analysis of SEC as a network of complex relationships in which social and environmental variables interact (Ostrom, 2009). The SES framework emphasizes the variables that prompt interactions in the system and highlights the existence of contextual determinants that limit the interactions and/or responses to the conflicts. While local analysis of SEC facilitates a study of this nature, we consider it important to scale the use of the conceptual framework up

Table 3
Percentage of studies combining two variables.

Action situation	Resource system and Units			Actors						Governance			Exogenous conditions	
	Sector	Ecosystem services	Characteristics of the sector	Local	Private	Governmental	Non-governmental	Activist	Gender perspective	Local organizations	Land tenure system	Rules and sanctions	Socioeconomic and political drivers	Climate patterns
Drivers of the conflict (N=36)	83,3	13,9	25,0	94,4	94,4	94,4	72,2	36,1	16,7	66,7	58,3	8,3	83,3	38,9
Social and environmental impacts (N=36)	83,3	13,9	25,0	94,4	94,4	94,4	72,2	36,1	16,7	66,7	58,3	8,3	83,3	38,9
Mobilization (N= 32)	87,5	15,6	28,1	100,0	93,8	93,8	78,1	37,5	18,8	71,9	62,5	9,4	84,4	37,5
Alternatives for management and resolution (N=15)	93,3	20,0	33,3	100,0	100,0	100,0	73,3	46,7	20,0	60,0	66,7	13,3	93,3	53,3
Future scenarios (N=8)	75,0	12,5	37,5	87,5	100,0	100,0	75,0	37,5	37,5	62,5	75,0	12,5	75,0	50,0

Rating scale (%)

Very high 81-100 | High 61-80 | Middle 41-60 | Low 21-40 | Very low 0-20

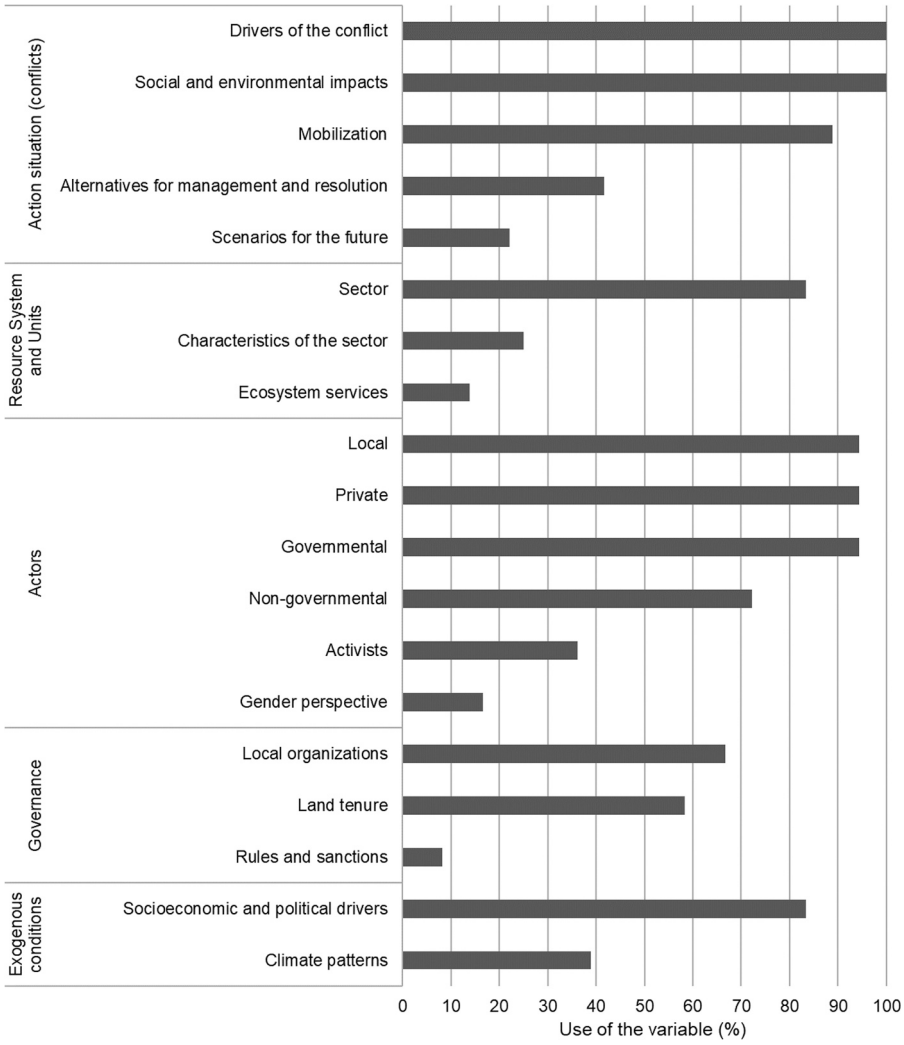

Fig. 4. Proportion of studies of socioecological conflicts in Mexico that mention the variables of the framework of socioecological systems. Adapted from MacGinnis and Ostrom (2014).

to the regional level, so that quantification of the conflicts and analysis of their causes contributes to a better understanding, and to envision ideas for their management and resolution (Barli et al., 2006).

There are four studies with the highest number of variables considered (16−18), three geovisualizers: Environmental justice atlas (https://ejatlas.org/), Canadian mining in Latin America (http://www.micla.ca/conflicts/) and the Mexican observatory of conflicts over the water (http://ocam.imta.mx/inicio.html), and the book of Azamar-Alonso and Rodríguez-Wallenius (2020). The three geovisualizers are promoted by researchers from Universities and Research centers, giving a structure to the information collected, guiding the users towards providing a detailed conflict characterization, and giving the facility to share additional materials to support the information offered on the website. Similarly, the book is a compilation of eight chapters written by scholars from two Mexican Universities who participate in a Seminar on socio-environmental conflicts.

Characterization of the action situation in the studies reviewed implied understanding the causes of the conflicts, the damages perceived, and the mobilizations unleashed. It should be noted that many of the studies did not conduct an exhaustive analysis of the elements that either favor or limit the occurrence of the conflict. Also, the information presented is based mainly on newspapers or journal articles, which impedes addressing in any depth the underlying causes and affectations of the conflicts at regional level.

The review of the studies revealed scant attention paid to alternatives of conflict management (41.7%) and planning for future scenarios (22%). The paucity of proposals and alternatives has been documented at global level by Scheidel et al. (2020). To generate alternatives of solutions, it is necessary to make the demands of those affected explicit, including payment or compensation for damage or rehabilitation of an affected area, and to highlight the local proposals for the management and conservation of ecosystems.

Regarding the consequences, some of the studies predict an increase in violence and migratory processes and greater deterioration of the environment (Becerra et al., 2006; Sánchez et al., 2019; Azamar and Rodriguez, 2020). However, there could also be positive outcomes derived from the conflicts, such as a strengthening of social mobilizations with the objectives of environmental defense and equity (Temper et al., 2018). There is an evident need to analyze the causes and consequences of the conflicts in the long term and to provide information regarding the vision of actors in terms of future scenarios in order to develop sustainable socioecological objectives (Svenfelt et al., 2019), in which human beings are considered part of nature (Okpara et al., 2018).

In the specific characterization of the resources and unit systems, most studies indicate the resource or resources affected in the SEC, but only some studies that focus on water and mining conflicts describe the characteristics of the resource (Delgado Ramos, 2013; Azamar and Ponce, 2014). A more profound exploration of the resource and unit

systems could allow a promotion of their defense, determination of the possible interactions with other components of the system, development of processes of auto-organization for management and avoidance of the escalation of conflicts (Ostrom, 2009). One form of characterization of the resources is through identifying the ecosystem services or values of nature and its benefits to people, since these are directly related to the conservation status, management of the system and the potential for access to the resources (Daw et al., 2011; Chaudhary et al., 2018). However, most of the information sources reviewed (86.1%) do not mention them. Jorda-Capdevila and Rodríguez-Labajos, (2015) indicate that the introduction of the ecosystem services approach in the analysis of conflicts allows for the identification of the components of nature and their relationship with the benefits they provide. Also, the identification of the unequal distribution of resources incentivizes the communication among interested parties. In this way, its incorporation into the analysis could allow the determination of how and who benefits from the ecosystems in the framework of justice, equality, and wellbeing (Horcea--Milcu et al., 2016).

In terms of the actors involved, their characterization allows for the identification of the degree of heterogeneity and, thus, the asymmetries of power and interests associated with the units system in conflict (Walker et al., 2000). There are studies that show that resource management becomes more complex when the groups involved tend towards heterogeneity. For example, they have interests, values and characteristics that differ considerably among them (Margreiter et al., 2005). This absence of recognition of the diversity of actors and their rights minimizes the importance of power relations, inequality, systems of governance, and the complexity of social networks when SEC are addressed. In this sense, the results of this study highlight the diverse actors involved, which can include the private sector, government, and the communities involved in the conflicts. The identification of actors evidences their heterogeneity as well as the wide rift of power asymmetries among antagonistic actors that must be considered when managing conflicts or when proposing elements for their management and resolution.

On the other hand, in reference to the actors indicated in the analysis of conflicts, we found an information gap related to a gender approach. Although literature exists that highlights the importance of elucidating differences in the affectations according to gender as a result of SEC (Gordillo, 2008; Fröhlich and Gioli, 2015; Aguera-Cabo, 2006), and the participation of women in social movements (Agarwal, 2000; Pandolfelli et al., 2007; Veuthey and Gerber, 2010), in this analysis, we found that more than 80% of the cases analyzed failed to differentiate between men and women. This gap could lead to limited reach in terms of the understanding of conflicts and the proposals put forward for their resolution through a failure to recognize that women can have a different degree of vulnerability. For example, this can come through not possessing land tenure rights or by having a lesser participation in decision-making in terms of resource management (Agarwal, 2000).

With regards to governance, scant attention is given to the rules and sanctions when SEC are described. Of our cases, only 8.3% of the consulted sources reported this, despite the fact that around 30% of the cases identified occur in territories with collective land tenure. In the Mexican context, there is a geographic coincidence between indigenous territories and regions of high biological value (Boege, 2008; Toledo, 2001). These territories present self-management models of governance in which resource management is practiced in adherence to clear and defined rules (Merino, 2006). For this reason, it is important to explore further aspects of local governance for the design of suitable proposals for the management and resolution of SEC.

With regards to exogenous conditions, most of the studies (83.3%) consider the social, economic, and political factors that frame the system in which the conflict is triggered. Aspects that are prominent as generators of conflict include the neoliberal model, the growing demands for raw materials that has led to the overexploitation of natural goods, and solutions based on the provision of goods and the free market. The studies also show some political aspects, such as the influence of foreign capital and international bodies in structural adjustments, development plans, reforms, and national laws. Generally, the latter fail to consider aspects of well-being, contextual cosmovisions, local governance and sustainability (Appendix C). The influence of national and foreign capital on projects that generate conflicts has also been reported in Chile (Carranza et al., 2020). These results reflect how political and economic powers can harm the rights of local inhabitants. When affected actors manifest their inconformity and demand their rights, conflict is triggered, presenting an opportunity to reconsider the projects and public policies that harm them (Paz, 2012).

Finally, environmental patterns are an important variable to consider in the analysis and management of SEC at a regional level. The predicted climate change, water scarcity, biodiversity loss, and inequalities in the distribution of costs generated by pollution will surely generate a greater rift in environmental vulnerability and a greater number of SEC in the coming years (Schaar, 2018). However, these characteristics are only marginally addressed, highlighting the need for future studies to explore these factors in depth so that it may be possible to prevent or achieve an integral management of SEC.

5. Conclusions

Global economic growth and the problems generated by climatic change will increase the number and violence of socioecological conflicts in the coming decades (Schaar, 2018). Addressing SEC with an integral and transdisciplinary approach is urgently required in order to allow an understanding of the underlying causes of conflicts, the analysis of the social and environmental impacts, and the generation of proposals for sustainable territorial mangement.

While efforts to characterize and analyze SEC in Mexico have increased in the last decade, the main findings of this review highlight: (a) the absence of a conceptual approach in most studies, (b) the limited characterization of conflicts regarding the definition of their causes, affectations and mobilization, c) a limited analysis regarding alternatives for their management and resolution as well as a restricted approach depicting future scenarios, (d) a weak understanding of environmental aspects or patterns and lack of analysis of ecosystem services, (e) the recognition of constant confrontations among local, private, and governmental actors, (f) a very incipient inclusion of a gender approach, among other aspects needed for a better understanding of the heterogeneity of actors involved, (g) the limited inclusion of rules and sanctions in the variables of governance, and (h) the emphasis on social, economic and political contexts as exogenous drivers of SEC.

There is a growing interest in understanding and addressing SEC, and the need to evidence and document them. However, the conceptual approach is absent from the studies reviewed. This approach could lead to a systemization and use of variables that reflect the complexity of the social and environmental interactions of conflicts. While there is evidence of the importance of including variables related to the design of rules and sanction, the monitoring of resources in dispute, cooperation and organization of the local actors (Barli, 2006; DuBois and Zografos, 2012; Baeta et al., 2018), these elements are only considered in a limited manner in the studies identified in Mexico.

It is suggested that an integral framework such as that of SES can offer elements for the characterization and analysis of conflicts at the regional level, addressing and relating in greater depth the interactions among environmental and social variables that may favor the understanding of the context and the underlying causes of conflicts. It is expected that an understanding of SEC from this perspective will allow the development of concrete proposals that can contribute to the management and peaceful resolution of conflicts.

CRediT authorship contribution statement

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geovisualizers and documents, Writing - original draft, Codification of the database and Writing-review & editing final draft. **Alma L. Trujillo-Miranda**: Conceptualization, Revision of geovisualizers and documents, Writing - original draft, Codification of the database and Writing-review & editing final draft. **María Elena Méndez-López**: Conceptualization, Revision of geovisualizers and documents,Writing – original draft, Writing - review & editing. **Luciana Porter-Bolland**: Conceptualization, Revision of geovisualizers and documents, Writing – original draft, Writing - review & editing. **Claudia María Monzón-Alvarado**: Conceptualization, Revision of geovisualizers and documents, Writing – original draft, Conceptualization. **Irina Llamas-Torres**: Conceptualization, Revision of geovisualizers and documents,Writing – original draft. **Ivet Reyes-Maturano**: Conceptualization, Revision of geovisualizers and documents. **Jibram León-Gónzalez**: Conceptualization, Revision of geovisualizers and documents. **Lilian Juárez-Téllez**: Conceptualization, Revision of geovisualizers and documents, Writing – original draft. **María del Rocío Ruenes-Morales**: Conceptualization, Revision of geovisualizers and documents, Writing – original draft. **Mariana Rivera-De Velasco**: Conceptualization, Revision of geovisualizers and documents,Writing – original draft. **Nicolás Chan-Chuc**: Conceptualization, Revision of geovisualizers and documents.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2021.10.008.

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