

International Journal of the Commons
Vol. 10, no 1 xxxx 2016, pp. x–x
Publisher: Uopen Journals
URL: <http://www.thecommonsjournal.org>
DOI: 10.18352/ijc.623
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ISSN: 1875-0281

Collective action in a tropical estuarine lagoon: adapting Ostrom's SES framework to Ciénaga Grande de Santa Marta, Colombia

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Abstract: The paper contributes to the social-ecological systems literature by adapting and using Elinor Ostrom's Social-Ecological System (SES) framework in the context of a coastal ecosystem. We modified the SES framework in the case of the Ciénaga Grande de Santa Marta (CGSM), an estuarine lagoon in the Caribbean coast of Colombia. The ecological importance of CGSM and its species is undeniable. This paper aims to understand why collective action for a sustainable use of CGSM's fishery resources has not taken place. In order to respond to that question, we created new variables within the social, economic, and political settings of the SES framework. The results show that the fishers' fear of the indiscriminate and strong violence that illegal armed groups have inflicted on them since the 1960s and the economic development in the Colombian Caribbean region help explain the lack of collective action.

Keywords: Ciénaga Grande de Santa Marta, collective action, Colombia, common-pool resources, conflict, fisheries, Social-Ecological System (SES) framework

Acknowledgement: We thank INVEMAR's researchers, especially Efraín Viloría and Myriam Vargas for providing outstanding support for this research. Special thanks to Micaela Kulesz for her support and discussion in the early stages of this paper. We appreciate very much comments from Ana Maria Roldan on an early version of this manuscript. We are very thankful to CGSM's fishermen, in particular fishermen from Tasajera, because without their help this research would not have been possible. We would like also to express our gratitude to INVEMAR's field assistants in CGSM, in particular to Vladimir Carbonó for his valuable and constant support. Likewise, we want to thank Rubén Vásquez and Alexander Acuña for all their assistance in the field when we conducted the survey. We also appreciate comments received in an early version of this paper from participants in the WOW5 Conference at Indiana University. We value the editing work done by Joanna Broderick. Finally, we would like to thank two anonymous reviewers who have contributed valuable comments. This research was funded and supported by the Leibniz Center for Tropical Marine Ecology (ZMT) and the German-Colombian Center of Excellence in Marine Sciences (CEMarin).

1. Introduction

Artisanal fishing is the main source of livelihood for millions of households in coastal areas of developing countries and plays a crucial role in food security and poverty alleviation (FAO and World Fish Center 2008). Thus, successful governance of fisheries is critical. Scholars of the commons have studied the management of common-pool resources (CPRs), including fisheries (Wade 1988; Ostrom 1990; Ostrom et al. 1994; Baland and Platteau 1996; Agrawal 2001; Ostrom and Nagendra 2006), and show that solutions that work in one scenario (Ostrom 1990; Schlager 1994; Ostrom et al. 1999; Basurto et al. 2013; Orensanz et al. 2013) may fail in another context (Hilborn et al. 2005; Medina et al. 2007; Basurto et al. 2013; Orensanz et al. 2013).

Due to the fact that the resource units in a fishery lack storage capacity, their management represents a bigger challenge than other types of resources such as forests (Schlager et al. 1994). However, in the fisheries management literature, it is possible to identify some key factors that influence sustainable management, such as a high dependence on the resource, the presence of property rights, the possibility for communities to develop their own rules, moderate or high levels of trust and reciprocity, local leadership, and local ecological knowledge (Ostrom 1990; Schlager et al. 1994; Basurto et al. 2013; Frey and Rusch 2013; Orensanz et al. 2013). However, other factors such as open-access regimes, big fisheries, large groups of users with severe heterogeneity of interests, the lack of rules or norms to manage the resource, and top-down management are stated as responsible for institutional and ecological failure of a system (Ostrom 1990; Schlager et al. 1994; Acheson 2006; Poteete et al. 2010; Basurto et al. 2013).

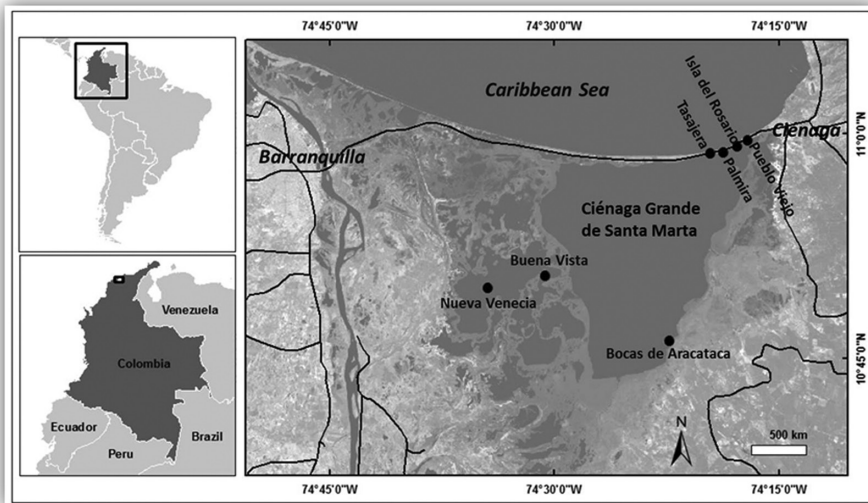


Figure 1: Tasajera and Ciénaga Grande de Santa Marta, Colombia.

Source: Map produced by Dr. Guiying Li. Center for Global Change and Earth Observations. Michigan State University.

This paper examines Ciénaga Grande de Santa Marta (CGSM), an estuarine lagoon located in the Caribbean coast of Colombia (see Figure 1). CGSM is located in the center of a bigger region (about 4900 km²) known as Eco-region Ciénaga Grande de Santa Marta¹ (Eco-region CGSM); it is separated from the Caribbean Sea by a 212 km² sand bar called Salamanca Island, declared as a Natural National Park in 1964 (Leal-Flórez 2007; Vilardy and González 2011). The Magdalena River and the rivers originating in the mountain system Sierra Nevada de Santa Marta (SNSM) provide the fresh water necessary to maintain CGSM's hydrological regime and fishing productivity (Leal-Flórez 2007; Vilardy and González 2011). This estuarine lagoon is important due to its large size (450 km²), its wide diversity of fauna and flora, and because it has one of the highest rates of primary productivity in the world (Gónima et al. 1996; Gocke et al. 2003). CGSM is the main source of both food and income for about 25,000 people who live in seven small surrounding villages: four located on the highway that connects Ciénaga and Barranquilla – Isla del Rosario, Palmira, Tasajera, and Pueblo Viejo (urban area) – with approximately 22,000 inhabitants (SISBEN 2012) and three stilt villages located within CGSM – Nueva Venecia, Buena Vista, and Bocas de Aracataca – with a population of about 2400 (SISBEN 2007, 2012).

¹ This eco-region includes 570 km² of marine area and 730 km² of an estuarine system of coastal lagoons, connecting creeks, and mangrove swamps.

Given the social and ecological importance of CGSM, it was declared a Fauna and Flora Sanctuary in 1977, a Ramsar Site in 1998, and a UNESCO Biosphere Reserve in 2000. Due to all these designations, CGSM is under a special environmental protection regime described in the Management Plan for the Fauna and Flora Sanctuary and the Management Plan for the Ramsar Site and Biosphere Reserve. In addition, it is regulated by several agreements, resolutions, and decrees existing in Colombia for the exploitation and management of fishery resources. Despite this, no State entity or organization currently regulates access and fishing activities in the lagoon. So, although de jure the protection of CGSM and the whole Eco-region CGSM resides in several government designations, de facto it is under an open-access regime.

This lack of environmental authority in CGSM is reflected in the environmental degradation experienced there since the end of the 1950s due to several anthropogenic activities which “have severely altered hydrological dynamics, reduced mangrove forest coverage and affected the composition of fisheries” (Vilardy et al. 2011, 1423). In consequence, some important fishery resources have disappeared (e.g. Ostra – *Crassostrea rhizophorae*) or are in risk of collapse (e.g. Jaibas – *Callinectes spp.* and Lisa – *Mugil incilis*). Another example is the fact that in 2014 more than 900 hectares of mangrove forest were devastated by fires, seemingly caused by landowners who resorted to slash-and-burn to clear land and expand their plantations (Ibarra et al. 2015).

This paper aims to understand why collective action for sustainable use of CGSM’s fishery resources has not taken place despite the fact that fishermen have been aware of the resource deterioration for many decades. In order to answer this question, we used an updated version of Ostrom’s diagnostic Social-Ecological System (SES) framework (2009). Due to the characteristics and context of this particular ecosystem, we found it necessary to stress the importance of the social, economic, and political settings (the S variables in the SES framework; see Figure 2) more than other literature has done. In order to accomplish that, we subdivided the economic development (S1), the demographic trends (S2), and the political stability (S3) into new variables to better answer the question motivating this study. The inclusion of these new variables is an important contribution to the application of the SES framework, because it shows how the system itself cannot be explained comprehensively without taking into consideration the context (geographic, social, economic, political) in which the system is embedded.

2. Ostrom’s framework to analyze social-ecological systems

The SES framework is generic and provides a common frame that can be used to study different characteristics of a social-ecological system, which permits not only making comparisons among them but also the study of a system over time. Since its first publication (Ostrom 2007), the SES framework has been updated (Ostrom 2009, 2011; McGinnis and Ostrom 2014), and enhanced through the

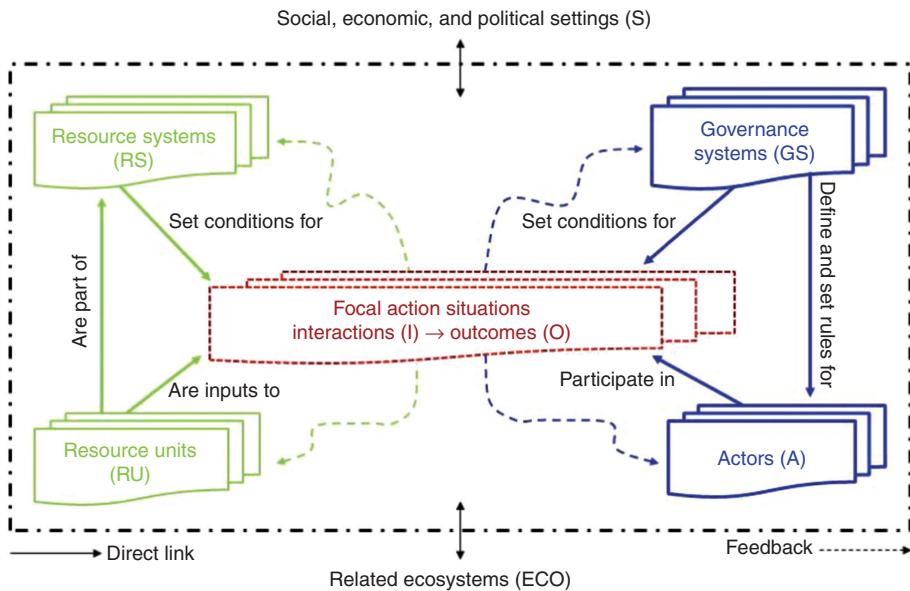


Figure 2: Revised Social-Ecological System (SES) framework with multiple first-tier variables. Source: McGinnis and Ostrom 2014.

provision of clear criteria for ordering concepts into tiers, refining the existing concepts, adding new concepts, defining outcome metrics, and representing the dynamics in the framework (Hinkel et al. 2014). With regard to fisheries, it has been instrumental in the analysis of sustainability and cooperation among fishermen, using different methodological approaches which range from case studies (Basurto and Ostrom 2009; Aswani et al. 2013; Ernst et al. 2013) to large-scale studies (Gutiérrez et al. 2011; Cinner et al. 2012; MacNeil and Cinner 2013).

According to Ostrom (2007), the starting point to study a linked SES is to develop a conceptual map that captures the highest-tier variables proposed in the SES framework (see Figure 2). On this level, the framework is composed of the resource system, the resource units generated by that system, the governance system, the actors in that system, and the focal action situations – interactions and outcomes. These components affect and are affected by the particular social, economic, and political settings and by characteristics of other related ecosystems. Furthermore, other ecological, social, and governance systems can exist interwoven with the system analyzed (McGinnis and Ostrom 2014). On the second-highest tier, the SES framework divides these categories into new sub-categories, which in turn can be subdivided again into other sub-categories and so on, depending on the social-ecological system being studied and the goal of the research.

The SES framework has been adapted in order to enhance its capacity to analyze complex SESs and its application by social and natural scientists, as well as by

communities that use and manage CPRs (Hinkel et al. 2015). Early on, scholars realized that less emphasis was placed on ecological variables in comparison to social variables in the framework. Due to these limitations on the ecological side, propositions of substantial expansion of the framework have been made. Epstein et al. (2013), proposed the addition of a new subsystem – Ecological Rules – to include in the analysis of SESs' laws, theories, and principles developed by natural scientists, especially regarding physics, chemistry, and biology. Additionally, Vogt et al. (2015) incorporated a list of ecological attributes into the resource systems (RS) and resource units (RU) subsystems.

Closer to our approach, other studies have pointed out that the framework needs to be expanded to acknowledge the political context in which the SES is embedded. Epstein et al. (2013) remark on the limitations of the framework to analyze power relations. Delgado-Serrano and Ramos (2015) use the SES framework as a policy planning tool, and thus needed to expand the social, economic, and political settings variables (S) to understand the context that surrounds a particular SES. Those S variables were considered, in the original SES framework to be outside the SES (Figure 2). In our study, as we mentioned in the introduction, we include an extension of the S variables by subdividing the economic development (S1), the demographic trends (S2), and the political stability (S3) into new variables to better answer the question motivating this study.

3. Methods

The three authors visited CGSM and in particular Tasajera in June 2011. During this visit we organized a small workshop with fishermen to inquire about social, economic, and ecological problems affecting CGSM. This information together with an exhaustive literature review allowed us to have a first approximation of the fishery's and its inhabitants' problems. We then elaborated 250 open questions, which were answered mainly through informal interviews conducted in August 2011 by the first author. In total, she conducted 75 interviews: 70 fishermen, 3 community leaders, and 2 key informants (locals other than fishermen with a very good knowledge about CGSM's history). Some questions were answered by many interviewees and others by only a few until saturation was reached. In the case of the fishermen from the stilt villages, she interviewed some of them in the fish market and visited their communities to conduct focus groups based on the questions we had identified as essential for that particular group. The community leaders and key informants were identified with the help of fishermen and researchers who had worked previously in the area. Those interviews gave us a better understanding of CGSM, its problems, and history, and enabled us to refine questions for our diagnosis.

To explain the lack of governance in CGSM and its consequences, we elaborated a new set of questions that resulted in two questionnaires; the first contained 110 questions and was answered by fishermen, community leaders, and key informants (interviewees responded to only some questions, according to their

knowledge about CGSM), and the second one had 40 questions and was answered by a group of scientists – either working in research about or being involved in the management of the CGSM’s fishery – with extensive knowledge in different themes related to CGSM (e.g. population dynamics, fishing practices). These scientists were identified with the help of researchers at the Institute for Marine and Coastal Research (INVEMAR) working in the region,² and then through snowball sampling. The first author conducted the semi-structured interviews between November and December 2012 with 45 fishermen, 3 community leaders, 7 key informants, and 15 scientists.

For aspects of the diagnostic framework that are better assessed for a higher number of respondents, we conducted a survey with 172 fishermen in February 2013.³ They were selected from SIPEIN (INVEMAR’s Fisheries Information System), a database consisting of 1014 fishermen who landed fish at the Tasajera fish market between 1999 and 2010. The inclusion criterion for selecting 172 fishermen out of the 1014 was the number of available data points. This criterion enabled us (1) to guarantee that each selected fisherman had sufficient data entries and (2) to select particularly active fishermen of the lagoon, who can be assumed to be the most important fishermen for a diagnosis of sustainable governance of the SES. The questionnaire included questions about individual and household sociodemographic aspects, environmental awareness, social capital, trust, reciprocity, collective action, and external aid received.⁴

4. Results

In our initial approach to this fishery, we used the SES framework as presented in Ostrom (2009) as a guide to develop our questions. However, in the field we realized that in order to achieve a comprehensive understanding of this fishery, we needed to look at the variables of the social, economic, and political setting. The armed conflict, around drug smuggling and armed group fights, has terrified the CGSM dwellers in the last several decades. This political situation has a substantial influence on resource governance and collective action in CGSM, including the fishery. Additionally, regional economic development activities, for example the construction of a highway, the deviation of rivers, agro-industrial activities and other farming practices done in areas close by, have affected the fishery in a manner that makes collective action more difficult. In the following fieldwork, we developed a list of questions based on the second- and third-tier variables in the social, economic, and political settings present. This later resulted in the extension of the S variables presented in Table 1.

² INVEMAR is an entity of mixed character (i.e. public and private). It is responsible in Colombia for doing basic and applied research on the natural renewable resources and the environment of coastal and oceanic ecosystems.

³ The first author administered the survey with the support of two survey takers, previously trained and with extensive fieldwork experience with rural communities.

⁴ Previous to the survey administration, we tested the questionnaire in seven pilots.

Table 1: Extension of the social, economic, and political settings proposed by this study.

Social, economic, and political settings (S)	
S1 – Economic development	
S1.1	Road development
S1.2	Farming and livestock development
S1.3	Agro-industrial development
S2 – Demographic trends	
S2.1	Forced displacement of civilians
S3 – Political stability	
S3.1	Internal armed conflict
S3.1.1	Military and police forces
S3.1.2	Illegal armed groups
S3.1.2.1	Guerrillas
S3.1.2.2	Paramilitaries
S3.1.2.3	Emerging Criminal Bands (BACRIM)
S3.2	Common crime
S3.3	Drug trafficking
S3.4	Political violence
S3.5	Corruption

The inclusion of these variables has two purposes. First, they draw attention to the relevance of the social, political, and economic context and its influence on other SES variables (Dietz and Henry 2008). Second, it allows us to analyze how external factors such as the Colombian conflict or the economic development of the Caribbean region have shaped the governance of the CGSM fishery and affected people's capacity to self-organize and to trust each other.

We start by presenting the social, economic, and political settings (S) and the different variables that we added within these settings to better understand this SES, and in particular how they help us explain why collective action to manage the fishery in CGSM is limited. Then, we focus only in those tiers of the SES framework that were relevant for our study.

4.1. Social, economic, and political settings (S)

CGSM has many special designations that are supposed to protect this important ecosystem, but none of the State authorities responsible for its management are effectively there. This abandonment is even worse when talking about agencies in charge of social, economic, and health issues. According to the scientists interviewed, the lack of basic services (e.g. electricity, drinking water), illiteracy and low levels of education, lack of schools and teachers – mainly in the stilt villages – make the living conditions in these communities precarious. This information is corroborated by official reports. Thus, according to the Administrative Department of National Statistics (DANE),⁵ in the villages located on the main road, 58%

⁵ The Administrative Department of National Statistics (DANE) is the public entity responsible for producing the official statistics in Colombia (<http://www.dane.gov.co>).

of households have “unsatisfied basic needs”⁶ (NBI) and 28% of people live in conditions of “misery.” In the stilt villages, 73% of households have NBI and 50% of the inhabitants live in conditions of misery (DANE 2012).

The absence of government agencies to protect the ecosystem and guarantee to these communities access to basic human rights like education, primary health care, adequate access to food, and other basic services, undermines the capacity for its inhabitants to act collectively and regulate the use and management of CGSM’s fishery resources. To make the situation worse, there are other factors we discuss below that make this particular case study even more complex.

4.1.1. Economic development (S1)

According to several studies (e.g. Botero and Mancera 1996; Botero and Salzwedel 1999; INVEMAR 2002; Aguilera 2011; Vilarity and González 2011) and scientists interviewed, in the last five decades Eco-region CGSM has been severely degraded by many anthropogenic activities associated mainly with the economic development (S1) of the Colombian Caribbean region. Below is a list of the most important events:

- a) The construction of the highway along Salamanca Island to connect Ciénaga and Barranquilla, two important cities on the coast (S1.1). This construction, done between 1956 and 1960, closed the natural connection between the Caribbean Sea and CGSM, which was 2000 m wide, and replaced it with a new channel called Boca de la Barra, which is only 80–100 m wide (Botero and Mancera 1996; INVEMAR 2002).
- b) The construction during the late 1970s of an unpaved road parallel to the Magdalena River, which interrupted the flow of fresh water from the river to CGSM (S1.1).
- c) The reduction of water flow from the Magdalena River to the lagoon, caused by the construction during the late 1960s and early 1970s of dikes and berms along its eastern bank and its distributaries to prevent flooding of agricultural and livestock lands (S1.1).
- d) The high sediment load from SNSM’s rivers and the Magdalena River and its distributaries, due to deforestation and erosion in their watersheds and expansion of livestock and agricultural areas for large crops such as cotton and bananas (S1.2).

⁶ In Colombia, the indicator of unsatisfied basic needs (NBI) takes into account several aspects. The households are classified as poor or suffering from NBI if they are, at least, in one of these situations: they live in a house made with materials considered unfit for human accommodation; there are more than three persons per room; there is no toilet nor aqueduct; the drinking water is obtained from a river or spring, rain water, or container truck; there are more than three people per employed member and the head of household has a maximum of two years of approved primary education; there is at least one school-aged child (between 6 and 12) relative of the head of household but he/she does not attend school. When a household has two or more of these situations, the household members are considered to live in a state of misery (DANE 2012).

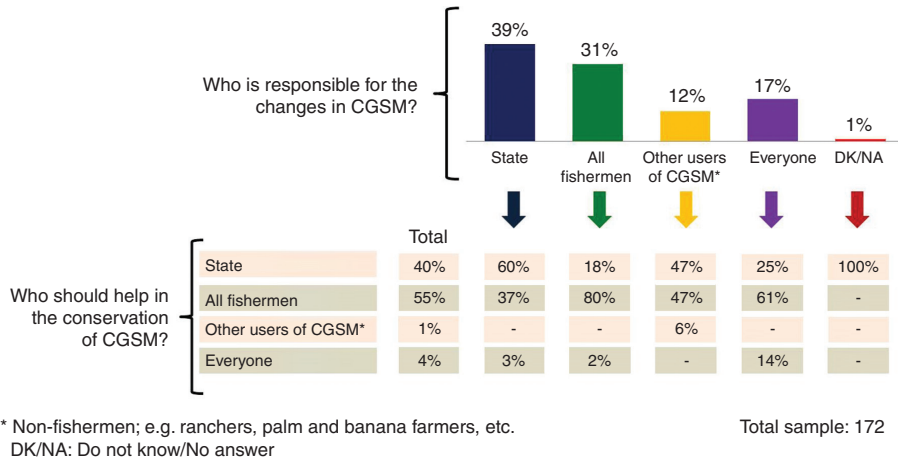


Figure 3: Fishermen's opinions about responsibility for the changes in and the conservation of Ciénaga Grande de Santa Marta (CGSM).

- e) The deviation of the freshwater flow from SNSM's rivers by ranchers and owners of extensive banana and oil palm plantations for irrigation systems (S1.3).

As a result of these activities, the lagoon suffered a drastic change in its hydrological balance. It has caused hyper-salinization, which in turn provoked (1) the massive mortality of almost 70% of its mangroves (about 360 km²) between 1956 and 1995 (Botero and Mancera 1996; Aguilera 2011), (2) the loss of some species of mollusks and fishes, (3) a drastic reduction in fishing productivity (Bautista et al. 2010), and (4) the massive die-offs of fish on repeated occasions (Mancera and Vidal 1994; Epstein et al. 1995). There is uncertainty about how all these factors have damaged the ecological system. As a consequence, fishermen's interest in finding solutions to manage their fisheries has been affected. We identified two reasons that help us to explain these results.

The first one is that the majority of the fishermen surveyed (81%) consider CGSM has suffered negative changes due mainly to the actions of the government, and because of overfishing and the use of nets with small mesh sizes. As shown in Figure 3, 39% of the fishermen consider the State is responsible for the changes in CGSM, and within this group, 60% think that it is the State's responsibility to conserve CGSM. It is important to note that only 31% of the fishermen believe that fishermen themselves are responsible for the changes in CGSM. The reasons they mentioned to justify that claim are the use of illicit fishing methods (e.g. *zangarreo*⁷) and nets with small mesh sizes, the pollution of the lagoon due to

⁷ *Zangarreo* is an active fishing method that involves one or more fishermen and consists of setting a gill net around mangroves and stirring up the muddy bottom to produce murky water, which causes asphyxia in the fish by clogging the gills.

their inadequate management of waste, and constant fishing that does not allow the lagoon time to recover. Interestingly, 55% of all the fishermen mentioned that the fishermen should help in the conservation of CGSM. However, it is clear that some factors prevent them from doing that.

The second reason that helps explain the lack of fishermen's interest in engaging in collective action after the degradation in the lagoon is that the deviation of the water from the SNSM's rivers generated many conflicts (I4) between fishers, farmers, and ranchers. The relationships among these three groups became very tense, which has led to violent conflict resolution. A comment from a Tasajera fisherman (2012) reflects this situation: "Where there are cattle, people are not allowed to enter to fish [on the banks of the swamps]. If they see a fisherman around, they will shoot him." This links us to the next issue, which is the political instability in the region and its consequences in fishermen's lives and their capacity to organize.

4.1.2. Demographic trends (S2) and Political stability (S3)

Colombia has been experiencing an internal armed conflict since the 1960s (S3.1). This conflict is complex and involves several actors: the government and its military and police forces (S3.1.1), illegal groups – the guerrilla groups (S3.1.2.1) on the far left (the Revolutionary Armed Forces of Colombia [FARC], the National Liberation Army [ELN], and the Popular Liberation Army [EPL]), the right-leaning paramilitary groups (S3.1.2.2), the United Self-Defenses of Colombia (AUC)⁸ (S3.1.2.2), the drug traffickers (S3.3), and the Emerging Criminal Bands (BACRIM) (S3.1.2.3) – and in the middle of all this confrontation, the civil population (Yaffe 2011).

Eco-region CGSM has been severely affected by the violence. According to Vilarity and González (2011), the armed groups have been present in the region since the 1960s. The first violent groups to arrive were the security groups of the drug producers and traffickers (S3.3). Then, in the 1980s, FARC (S3.1.2.1) and AUC (S3.1.2.2) came to the region. Later, in the mid-1990s, ELN (S3.1.2.1) settled in the area and began to exert control over the fishing gear used in the lagoon, especially not allowing the use of the encircling gill net (known as *boliche*). These activities together with the struggle among the armed groups to control this territory, which is strategic for smuggling of weapons and drugs, increased violence in the region. As a result of these struggles, the guerrillas (S3.1.2.1) were thrown out almost entirely and the paramilitaries (S3.1.2.2) began to control the area, which included subordinate self-defense groups (S3.1.2.2), control of drug trafficking (S3.3), making political deals to control the public entities in the region (S3.4, S3.5), and the intimidation and murder of civilians to instill fear.

The most violent actions against the rural population were five massacres committed between January 1999 and November 2000 in the stilt villages and two

⁸ Later became paramilitaries.

communities near CGSM, Piñón and Pivijay (Vilardy and González 2011). The massacres were committed with the accusation that fishermen and peasants were sympathetic to the guerrillas (S3.4). This caused a massive displacement (S2.1) of more than 1000 fishermen to the villages located on the highway that connects Ciénaga and Barranquilla (Aguilera 2011; Vilardy and González 2011). During our visits, we found that many of these displaced people have not returned to their home villages for fear of being killed.

According to Vilardy and González (2011), paramilitaries (S3.1.2.2) were responsible for extortions, selected murders, enforced disappearances, and threats against public servants (S3.4) in this region for various years. Additionally, they controlled the production and trafficking of drugs in the area (S3.3). In 2002, they began a peace process with the government that finished with the demobilization of all their members by 2006. However, it was reported in our interviews that paramilitary groups (S3.1.2.2) are reorganizing, extorting, and threatening civilians, and exerting control in some areas around the lagoon.

At the end of 2012, there was a new threat of massacre against civilians in Nueva Venecia. In addition, we were told that some people who expressed in meetings their disagreement with the fresh water deviation from SNSM's rivers were killed. This generated great fear among people. Researchers working in the area confirmed that many fishermen do not participate in meetings for fear of being killed. Additionally, some of the interviewers told us "informally" that BACRIM (S3.1.2.3) had appeared in the area. Apparently, they also control the drug trafficking and weapons trade, carry out extortions, kidnappings, tortures, murders, threats to politicians and the civil population, etc. (Vilardy and González 2011; Latorre and Arregocés 2014). Besides this, according to the police, the inhabitants of Isla del Rosario, Palmira, and Tasajera are victims of common crimes (S3.2).

For all the reasons described above, fishermen's willingness to gather, to create any type of association among themselves or with other users of the lagoon, or simply to participate in any collective activity is very limited. The risk of being murdered if one of the illegal armed groups in the region perceives them as collaborators with opponent groups has generated fear in the population. This conflict has weakened the social fabric, and therefore people prefer not to be involved in activities with other persons due to a breakdown of trust.

4.2. Resource systems (RS)

4.2.1. Clarity of the system boundaries (RS2) and size of the resource system (RS3)

CGSM is an estuary receiving salt water from the Caribbean Sea through the Boca de la Barra and fresh water from the Magdalena River and SNSM's rivers (Vilardy and González 2011), therefore the ecological boundaries of the system cannot be clearly defined (RS2). In addition, the size of the resource system (RS3) is large from the perspective of the particular ecosystem users. According to many fishermen interviewed, the decision to attend meetings is not easy because they

lose 1 day of work. Additionally, the food and transportation expenses are really high for people living in the stilt villages.

Another concern regarding the boundaries, according to key informants, is that fishermen from other municipalities located far away from CGSM (e.g. Barranquilla, Soledad, Sabanagrande) can fish in the lagoon without any restriction, which affects not only local fishermen's interest in conserving the lagoon but also the possibilities to organize the fishery. The following comments of a key informant evidence this situation:

The attitude that people have created is ... "I cannot conserve because what I conserve someone else will take, therefore we will finish it anyway" ... The philosophy that people have in their minds is why should we keep this for tomorrow if tomorrow the neighbor is going to steal from us, then we finish this off right away and we take advantage of this today; tomorrow we will see what to do. (Key informant 2012)

4.2.2. Productivity of system (RS5) and predictability of the system dynamics (RS7)

The fishery in CGSM was historically one of the most productive resource systems (RS5) in Colombia due to the magnitude of fish and shellfish caught (Botero and Salzwedel 1999).⁹ However, due to the severe hydrological changes, the catches of the main commercial species sharply declined. In fact, the Autonomous Regional Corporation of Magdalena CORPAMAG¹⁰ (1993) stated that between 1969 and 1982 the fish caught in CGSM went from 27,000 ton/year to 1600 ton/year (Botero and Botero 1989).¹¹

In 1992, the Project to Rehabilitate the Ciénaga Grande de Santa Marta (PROCIENAGA)¹² was launched. Its main goal was the "definition and execution of an environmental management plan for the improvement of the ecological, social, and economic conditions of the region" (Botero and Salzwedel 1999, 249). Between 1996 and 1998, this project re-opened six pre-existing channels that provided fresh water to the lagoon from the Magdalena River. It reduced the salinity in the soils and water of the lagoon, which in turn allowed the recovery of some areas of mangrove and an increase in the fish catches (INVEMAR 2003).

⁹ According to the National Institute of Renewable Natural Resources and Environment, between 1970 and 1975 CGSM met 70% of the local demand for fish on the Caribbean coast and the excess supplied markets in neighboring coastal cities and inland areas (PROCIENAGA 1995).

¹⁰ CORPAMAG is the government agency in charge of environmental management and control in the Department of Magdalena.

¹¹ According to CORPAMAG (1993), although these data can be underestimated due to the lack of complete information about the fishing products mobilized from CGSM in that period, the reduction in the volume of fish caught was evident.

¹² PROCIENAGA was a Colombo-German megaproject. Through several agreements, participants in the project included CORPAMAG, INVEMAR, German Agency for Technical Cooperation, Colombian Administrative Department of Science, Technology and Innovation, and the Regional Council for Economic and Social Planning. This 10-year project ended in 2002 (PROCIENAGA 1995).

However, the lack of maintenance of these channels by CORPAMAG has again produced changes in the hydrological regime of the lagoon and the reduction in fishing resources (Ibarra et al. 2014).

Additionally, other factors such as overfishing and use of illegal fishing gear and methods, together with all the other aspects already mentioned in the regional economic development (S1) setting have produced constant fluctuations in the fishing productivity over time (INVEMAR 2002; Ibarra et al. 2013; Ibarra et al. 2014). The variation in species abundance together with the reduction in the fish sizes were widely mentioned by fishermen interviewed. These changes do not allow fishermen to make accurate predictions (RS7) about the future productivity of their fishing system (RS5). This is another challenge fishermen are encountering if they try to organize and draft rules to manage their fishery. The following interviewee comments support that point:

One cannot predict when there will be scarcity or abundance of fish. It is random. (Tasajera fisherman 2011)

Before there were more fish, you arrived and caught right away. Now we have to look for them, they are smaller. (Tasajera fisherman 2012)

4.3. Resource units (RU)

4.3.1. Resource unit mobility (RU1) and spatial and temporal distribution (RU7)

Due to the nature of this lagoon, species are continuously mobile, which is well known by the fishermen (RU1). In fact, according to Santos-Martínez and Acero (1991) and Sánchez-Martínez and Rueda (1999), CGSM is used mainly by juveniles of different species of fish (RU7). Approximately 60% of native fishes in CGSM are visitors and the rest (40%) are residents (Santos-Martínez and Acero 1991; Sánchez-Ramírez 1996; Bateman 1998). Nowadays 109 species are commercially exploited in CGSM, of which 94 are fishes, 4 are mollusks, 9 are crustaceans, and 2 are reptiles. Among all these species, 56 have marine affinities, followed by freshwater (30) and estuarine (23) species (Ibarra et al. 2014). This connection to the sea and the exchange of fish was used by various fishermen to explain that CGSM has an endless reservoir of fish for them to exploit. So, some fishermen may believe there is no need to develop rules to manage the CGSM fishery, given that apparently resource units keep entering the system. Some fishermen's opinions show these thoughts:

If La Barra does not close, the Ciénaga is not exhausted. The Ciénaga depends on the rivers. The river is a necessary thing for the Ciénaga. (Tasajera fisherman 2012)

The Ciénaga will not have fish deprivation because the ocean maintains the fish population. (Tasajera fisherman 2012)

The sea throws fish outside [into the Ciénaga]. Some fish also enter through the rivers, so there [are] always fish. (Palmira fisherman 2012).

4.4. Governance system (GS)

4.4.1. Government organizations (GS1) and monitoring and sanctioning rules (GS8)

Even though Eco-region CGSM is under a special protection regimen, we did not find any government entity (GS1) supervising the access and/or use of the fishery during our visits. This observation was corroborated in the interviews with fishermen and scientists. The situation is aggravated because the government agencies responsible for the fisheries management have changed several times during the last few decades and have had limited staff (Vilardy and González 2011). This situation is further aggravated by threats some of the public servants receive from the illegal armed groups in the area.

Nowadays there are only two government entities that are permanently in the area: National Natural Parks of Colombia and INVEMAR, but neither is charged with monitoring or controlling the fishery. This lack of formal monitoring and sanctioning processes (GS8), together with blame that the State disrupted the lagoon, was mentioned by all the scientists and most of the fishermen interviewed. Here are two examples of their comments:

As the Ciénaga is so extensive and there is no control and monitoring, all the fishermen do whatever they want. (Bocas de Aracataca fisherman 2011)

The Ciénaga belongs to everybody and nobody. Anybody can arrive there and do what he wants and nobody says anything. (Scientist 2012)

This situation has generated a complete distrust in the State and the feeling that the fishermen have been abandoned. At the same time, since fishermen try to avoid conflicts among themselves, they prefer to avoid questions and comments about their peers' fishing gears or fishing methods, thereby impeding the capacity and willingness to self-organize.

4.4.2. Non-government organizations (GS2)

Due to the critical reduction of the fishing productivity of CGSM and the extreme poverty of its dwellers, in 1994 some government agencies together with PROCINAGA initiated a discussion process with representatives of various fishery resource users of CGSM. This process aimed to identify the problems and conflicts that were affecting the fishing activity and to find solutions to overcome the crisis (Botero and Salzwedel 1999). As a result of this process, they agreed to approximately 50 fishery management rules, which were to be implemented by June 1995 and were supposed to be the basis for developing a Fishery Management Program (PROCINAGA 1994). However, during the first half of 1995 a massive die-off of fish created substantial food scarcity for people, who then ignored the whole management process. The following comment from a scientist who worked in CGSM at that time reflects the situation:

Beginning in the 1990s [1993–1994], before the massive die-off of fish [1994–1995], due to a reduction in the resources, fishermen began to

self-organize to look for alternatives In that moment they created an Assembly of Fishing Communities to both conserve the Ciénaga and look for other economic alternatives. ... At that time they reached some agreements, but the massive die-off of fishes impeded fishermen in complying with them and they caught everything they found. (Scientist 2012)

Following this event, many entities (public, private, national, and international) arrived in Tasajera to develop all kinds of projects (e.g. socioeconomic, basic services, social relief, environmental) to both help the rehabilitation of CGSM and improve the fishermen's livelihoods. Many of these projects required people to be organized in order to get the financial aid (Botero and Salzwedel 1999; Vilardy and González 2011). The agencies, then, created groups without giving people the opportunity to self-organize, which did not allow them to generate a sense of ownership of their organizations.

According to some of our key informants and community leaders interviewed, after participating in several projects aiming to ameliorate life conditions of the people in CGSM, people decided to create a higher-level organization. Thus, in 1996 they formed the Association of Community Organizations of the Ciénaga Grande de Santa Marta (ASOCOCIENAGA), which grouped 58 small organizations from the seven communities that depend on CGSM. It allowed them to have a greater capacity for negotiation with these donor agencies and get more external aid. This organization, in fishermen's and scientists' opinions, worked relatively well while the individuals in charge of the projects accompanied them. Once they left, groups had difficulties due to problems of accountability, lack of interest, and individualistic behavior. The lack of rotation of the board of directors, the inappropriate management of the projects' information, and the same groups of people participating in all the projects undermined the trust of fishermen in this association. As a result, some of them decided to organize new groups independent from ASOCOCIENAGA. This situation was aggravated by the violence of the 1999 and 2000 massacres and subsequent fear to organize. The following quotes show this situation:

In the massive die-offs of fish we were organized but the groups were divided and they did not stay together. The groups think different things. There was a lot of disagreement; it was not possible to get only one conclusion. (Tasajera fisherman 2012)

People do not trust in those who lead projects because they use them to get the money but then they do not give them anything or very little. (Scientist 2012)

4.4.3. Collective choice rules (GS6)

During our visits to CGSM, we confirmed that there is no committee or community council left where fishermen discuss or create rules to manage their fishery. This is due in part to several factors mentioned earlier. The violence perpetrated by armed groups generates great fear among fishermen, and they prefer to avoid meetings or

any other activity that puts them or their families at risk. Additionally, a small group of fishermen surveyed (15%) believe the lagoon has enough fish for all of them and therefore they do not perceive any incentives to engage in collective action to manage the fishery. Moreover, another group of fishermen surveyed (40%) believe the State should take the lead in the conservation of the lagoon.

4.5. Actors (A)

4.5.1. Importance of resource (A8)

The artisanal fishery in CGSM has 3500 fishermen (Blanco et al. 2007), of which on average 950 are active daily in the lagoon (INVEMAR 2012). Fishermen depend mainly on the fishery or related activities such as buying fish or shellfish for resale, or cleaning canoes, nets, or fish in the fish market. Sixty-six percent (66%) of fishermen surveyed stated that they are fishermen because there is no alternative employment in the region. Apparently the strategic location of CGSM should allow fishermen to go fishing either in the lagoon or the Caribbean Sea; however, the canoes and fishing gear used to fish in the sea are different from those used in CGSM. For this reason, most surveyed fishermen (88%) depend only on CGSM (A8), while the rest (12%) benefit from fishing in both places.

4.5.2. Leadership (A5) and norms (trust-reciprocity)/social capital (A6)

In this SES, the lack of leadership (A5) is critical, and is due to very low levels of education, pressures from illegal armed groups on civilians, and the improper management of resources when external aid came. All these factors together with the threats and murders of any potentially new leaders have strongly disaffected the people's desire to participate in self-organizing activities. Comments from fishermen and leaders illustrate their difficult situation:

There are many threats and therefore people are afraid. What most affects the possibility of working together is the violence ... the threats are common throughout the area, including the stilt villages. (Key informant, 2012)

The members of armed groups infiltrate the fishermen's meetings. This severely limits the fishermen. Fishermen are afraid because in the last 3 years at least 10 community leaders have been killed. (Scientist 2012)

Given that trust is an important factor which facilitates cooperative behavior, we assessed the fishermen's trust in local government, farmers, ranchers, and traditional leaders. We asked fishermen to grade on a scale from 1 to 10 the level of trust they have in each one (1 meant that they distrust totally, and 10 that they trust completely). Regarding local government, we found that only 4% trust completely (scores 9 and 10), while 62% do not trust at all (scores 1 and 2). The remaining fishermen (34%) graded between 3 and 8. With respect to farmers and ranchers, the results show that 50% of fishermen distrust totally, 10% graded between 2 and 5, 5% graded between 6 and 10, and 35% preferred not to answer

that question. Finally, in relation to traditional leaders, we found that only 4% trust completely (scores 9 and 10) and 53% do not trust them at all (scores 1 and 2). The opinions of the remaining fishermen were divided: 13% scored 3 and 4, 23% scored 5 and 6, and 7% scored 7 and 8.

Many of the facts that we have described so far shape the social capital (A6) in this SES. Another way to evaluate it is through community activities, and as we expected they are uncommon. In fact, according to the survey results, 79% of the fishermen did not participate in any community activity in 2011. This lack of desire to participate in community activities is confirmed by the fact that 90% of the fishermen stated that people are only willing to participate in community activities when there is a payment.

4.5.3. Knowledge/mental models (A7)

Taking into account that fishermen's perceptions about the fishery resources of CGSM are key to understanding their behavior and their interest in self-organizing to regulate the fishery, we evaluated their perceptions about the current and future availability of fishery resources. We found that the majority (81%) believe the resources are beginning to become scarce, 15% believe there are a lot of resources for all, and only 4% said the resources have always been scarce. Likewise, 73% believe that if CGSM's fishermen continue fishing at the current rate, there will not be enough fish to feed their families in the future.

This situation is the result of the lack of information fishermen have about the ecological conditions of CGSM. Very few fishermen know the results of the monitoring of the water's quality, mangroves, and fishery in CGSM that INVEMAR has recorded since 1993. Even worse, CGSM is one of the ecosystems in Colombia where many biological studies are carried out, but most of the researchers do not disseminate their results to the fishermen of the region (Vilardy and González 2011).

5. Discussion

With our study, we wanted to understand why collective action for a sustainable use of fishery resources of CGSM has not taken place. In Table 2, we summarize the main results from the utilization of the SES framework and its adaptation.

The socioeconomic conditions of CGSM inhabitants are extreme. The State has abandoned them in all aspects of their lives. The daily difficulties for CGSM dwellers are aggravated by the Colombian civil conflict (S3) and the presence of drug traffickers (S3.3). The latter have dramatically affected the fishermen's desire and capability to organize, or even to express their own opinions. It was also found that some of the fishermen live in constant fear that something may happen to them or their families. Thus, one of the social consequences of the conflict is that it has destroyed many manifestations of social capital (A6), such as the creation of social networks, participation in community activities, or the possibility of having leaders (A5). The literature on collective action (e.g. Agrawal

Table 2: Main factors affecting collective action according to the SES diagnostic.

Influencing factors
– Political instability of the region caused by the presence of different armed groups (S3).
– Great fear by fishermen of the violence exerted by armed groups in this region (S3).
– Precarious living conditions of dwellers that depend on CGSM (S).
– Weakening of social capital from constant armed conflict (A6).
– Highway and road development in the Caribbean region that altered the hydrological regime of CGSM (S1).
– Expansion of farming, livestock, and agro-industrial sectors in the region (S1), which has caused a severe degradation to CGSM and generated conflicts (I4) among different actors present in Eco-region CGSM.
– Limited knowledge that fishermen have about CGSM (A7), which in turn does not allow them to make predictions (RS7) about its future productivity (RS5).
– Belief of some fishermen (A7) that the lagoon will always have fish.
– Belief that because the State (GS1) caused the deterioration of the ecosystem, it should also do something to protect it.
– High dependence on the fishery resources (A8) due to the lack of income alternatives.
– Coercion toward the new generation of leaders (A5).
– Distrust (A6) of fishermen in past/traditional leaders (A5).
– Lack of formal and informal monitoring and sanctioning processes regarding the fishery in CGSM (GS8).
– Absence of State agencies that control the fishery in the lagoon and protect the people (GS1).
– Lack of a committee or community council where fishermen collectively can create, change, or discuss rules regarding the fishery in CGSM (GS6).
– Effects generated by the external aid of NGOs (GS2) and State agencies (GS1).
– Unclear boundaries (RS2) due to the connections between CGSM, the Caribbean Sea, and SNSM's rivers.
– Continuous mobility of species (RU1) and their spatial distribution (RU7).
– Size of the lagoon (RS3), which is very large in terms of transportation for the fishermen given the technology they use.

2002; Poteete and Ostrom 2004; Poteete et al. 2010) talks about the importance of social capital as a crucial factor for the emergence of leadership and the creation of rules and norms. Clearly, social capital in CGSM has been minimized and exists only as interactions among family members and friends.

The lack of basic human rights such as education, peace, health coverage, and water and sewage systems affect people's ability to sustainably use the fishery resources of this lagoon over time (Ratner et al. 2014). Therefore it is fundamental to solve the human-rights problems in the region before any type of collective action can emerge. The absence of State authorities (GS1) not only prevents citizens from having some of their basic needs, it also allows illegal groups to become established, leaving citizens at the mercy of those armed actors (S3.1.2, S3.2, S3.3). According to the fishermen, the presence of State agencies (including military and police forces) would facilitate conditions to work again on the development of a fishery management plan for CGSM. These results are consistent with the findings of Botero and Salzwedel (1999) and Vilarity and González (2011), who stated that one of the core problems in CGSM has been the

deficient actions of entities responsible for the protection of the population and management of the lagoon.

In ecological terms, the literature on consequences of armed conflict on the environment reports two types of findings. On one hand, it can be “positive” when the conflict leads to a natural regeneration of the resource due to its inaccessibility (Adhikari and Adhikari 2010). On the other hand, it can be negative, thus the conflict drives resource destruction or loss of biodiversity (Hanson et al. 2009). In the case of CGSM, we found that the guerillas in the mid-1990s prohibited the use of *boliche* in the lagoon. According to the interviews, this imposed rule reduced the pressure on the fishery resources when it was going through a critical period. The rule, however, did not last and we do not have any ecological evidence to assess its benefits. Additionally, we found that when the paramilitaries (S3.1.2.2) left the area in 2006, many fishermen, particularly in Tasajera, began to again use the *boliche* and other unsustainable fishing methods such as *zangarreo*. This increased the pressure on the resource and generated several strong conflicts (I4), especially between Tasajera’s and the stilt villages’ fishermen.

Researchers have shown that the more predictable a resource is, the easier it is for its users to engage in collective action (Agrawal 2001; di Gregorio et al. 2008). In our study, we showed that external variables had severe ecological and social consequences and therefore may explain the lack of cooperation in CGSM. The road development (S1.1), the increase in farming and livestock (S1.2), and the intensive agro-industrial activities (S1.3) in the overall region have produced dramatic changes in the ecosystem and unpredictability of the resource flow (RS7), escalating fishermen’s distrust of the government and other local groups.

Additionally, studies done on fish populations in the region are not available to fishermen; therefore, for them the actual biological health of the system is unknown. This lack of a common understanding of the systems among resource users of CPRs has also been stated in the literature as a factor that could affect collective action, given that users find it difficult to agree on a joint strategy that allows them to conserve the resources (Poteete et al. 2010). In the case of CGSM, this situation has led fishermen to have diverse mental models (A7) regarding the health of the ecosystem and its productivity (RS5), which are not informed by the scientific studies conducted in the lagoon. Basurto and Ostrom (2009) show that the lack of significant knowledge about the resource prevents fishermen from making predictions about the dynamics of the system, which in turn affects their capabilities for self-organization.

The commons’ literature argues that when users depend largely on a CPR, they invest time and effort to create new institutions to govern it (Wade 1994; Dietz et al. 2003; Chhatre and Agrawal 2008). However, it is also claimed that collective action occurs among users when they perceive that the resource is moderately scarce (Wade 1994; Araral 2009). As shown in the results section, most of CGSM’s fishermen depend on the resources (A8), and they are aware that the productivity of the system (RS5) is declining, but they do not have enough

resources and leadership to self-organize. Moreover, since some fishermen still believe CGSM will always have fish (A7), the odds of reaching an agreement is not easy.

The presence of respected and recognized leaders by the community is another factor identified in the literature as a facilitator of collective action among resource users of a CPR (Wade 1994; Baland and Platteau 2000; Vedeld 2000; Onyx and Leonard 2011). However, in CGSM many factors, including the inadequate management of the resources and information of some projects, the lack of accountability, the untrustworthy reputation of leaders (A5), and the murder of some of the new leaders, have totally restrained people's interest to lead or participate in any community activity.

The existence of monitoring and sanctioning and other operational rules that allow resource users to maintain their resources is crucial to facilitate cooperation (Ostrom et al. 1994; Ostrom and Nagendra 2006). Nevertheless, in CGSM, the lack of State authorities (GS1) to protect the ecosystem and more important to protect the community itself from illegal armed groups (S3.1.2), common crime (S3.2), and drug traffickers (S3.3) leaves the community in an even more vulnerable situation. This lack of protection and the lack of support by the government to self-organize a council where fishermen can collectively decide how to manage CGSM's fishery (GS6) and agree on monitoring and sanctioning processes (GS8) have totally discouraged CGSM's fishermen.

Another factor discussed is the strong presence of external aid in CGSM, which links the factors non-government organizations (GS2), leadership and entrepreneurship (A5), and trust (A6). According to the literature, external aid can lead to the Samaritan's Dilemma, which hinders collective action in the long term (Gibson et al. 2005). The severe ecological, social, and economic problems of CGSM generated a huge influx of development assistance. We observed that people were organized to obtain money from external donors, resulting in 58 community groups. These groups were mostly single-issue organizations that disappeared or became inactive after the project ceased to exist. None of the projects has led to the organization of a self-sustaining fishery organization that can regulate fishery activities at a community level.

Regarding the system boundaries (RS2), one could argue that they are as clear as they can be in a fishery context, the lagoon having only one outflow of 100 meters to the Caribbean Sea, and that resource mobility (RU1) is rather limited, which should both favor collective action (Wade 1994; Wilson et al. 2007; Poteete et al. 2010). However, given that some fishermen consider CGSM as an endless reservoir of fishes due to its connection to the sea, some of them seem to believe that there is no need to create rules to manage the fishery. In addition, the fishery being "open" to other fishermen implies that local fishermen do not see the benefits of taking care of the fish in the lagoon. Obviously, not being sure if the benefits of conserving the lagoon can be gained by those who have engaged in it makes collective action more difficult (Schlager et al. 1994; Ostrom 2009).

6. Conclusion

In this paper, we used and adapted the SES framework proposed by Ostrom (2009) to investigate the factors that seem to affect collective action for a sustainable fishery in CGSM. As shown in many other studies (Ostrom 1990; Baland and Platteau 1996; Agrawal 2001), collective action is affected by multiple factors; however, in our study we are finding that the social, economic, and political settings used in the Ostrom SES framework seem to have influenced in a negative way all the other variables of the SES and therefore have had an immense influence in the lack of collective action in CGSM.

Regarding the application of the SES framework in CGSM, we realized it is a powerful tool that facilitates a systematic diagnosis of an SES. However, as in other studies, we stressed the importance of the external social, economic, and political settings. Our work complements the literature by focusing on this setting and creating new variables on the third, fourth, and fifth tiers within economic development (S1), demographic trends (S2), and political stability (S3) to be able to better explain how these external variables impact the SES, and its management. Without the two dominating factors – violence (political stability S3) and economic development (S1) – it would be impossible to comprehend the situation of this SES. This research contributes to the further refinement of the SES framework mainly in two ways: (1) to our knowledge only one other study exists, where the second-tier variables of the social, economic, and political settings have been developed, and (2) we are not aware of any other study using the SES where armed conflict explains and affects so strongly all the other variables of the system. Many collective action problems regarding natural resources management take place in environments that are dominated by contextual drivers outside the SES. This might be regional policies oriented to develop the region, for example. In many regions of the world we find violent conflicts affecting people's capacity to organize themselves. Therefore we argue that further research should take the social, economic, and political settings more deeply into consideration.

The region suffers from a high level of poverty and the lack of basic infrastructure, but this situation is aggravated by armed conflict and decisions made by the Colombian government. According to our findings, the way armed conflict has impacted the social interactions in the region helps to explain the lack of collective action among fishermen. Moreover, it has incentivized an individualistic behavior driven by the lack of trust and the fear of others in the community because of the presence of the illegal armed groups. As shown in this paper, the social, economic, and political conditions of the region have harmed the CGSM population in such a way that they do not have secure human rights. Many fisheries described in the literature have failed to be managed in a successful way because the causes of poverty and insecure livelihoods do not reside in the fisheries themselves but are external (Allison et al. 2012); this also seems to be the case in CGSM. Here, these external factors are strongly associated with a failure in the State's responsibility not only to protect the fishermen and their families (Ratner et al. 2014) but also to protect this important ecosystem.

Additionally, decisions that aimed to promote development in the Caribbean region brought about profound ecological disruptions in the ecosystem. Unfortunately, fishermen from CGSM saw their fishery affected in the long run without receiving any type of compensation, without provision for any economic alternatives, or even a new management plan for their fishery and this important ecosystem in light of its disruption. According to our findings, the Colombian government has regulations on paper that may help the ecological sustainability of CGSM but, in reality, does not exert any type of control or positive role in the fishery.

The Colombian government has the obligation to help these communities first by being present and guaranteeing that human rights are secure to all its inhabitants and second by empowering them through social inclusion and capacity building. Otherwise, CGSM's fishermen cannot organize to create sustainable use of the fishery resources of the lagoon over time.

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