The role of social capital and collective actions in natural capital conservation and management

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Abstract

The relationships among social capital (SC) and collective actions (CA) towards natural capital conservation and management were analyzed across five case studies in Latin America. Data on SC and CA were obtained through a semi-structured questionnaire to groups of selected social actors. Structural equations were used to identify SC components and to evaluate SC across actors and cases. The results reaffirm that: i) the multidimensional nature and complexity of SC; ii) Higher levels of SC are related to higher levels of CA; iii) social actors with developed internal and external SC can better counter adverse conditions through CA compared to actors who only have one type of SC; iv) vulnerable social actors do not necessarily have a higher SC or engage in more CA, despite their higher dependence on natural resources; v) those who hold more power or influence in the territory, have higher levels of SC and CA; vi) vulnerable actors often carry out social, economic and judicial actions, while dominant and structuring actors carry out more educational/technical and political actions. Therefore, the formation and maintenance of SC of the most vulnerable actors and those who support them must be a priority for political action, in order to counteract the asymmetric power relations that lead to the exclusion and marginalization of many rural actors.

Introduction

Despite the expansion of conservation actions worldwide, global biodiversity loss continues causing significant alterations to the Earth's ecosystems and the services they provide to humans (Cardinale et al., 2012; Hooper et al., 2012; IPBES, 2019). This outcome can be explained, at least partially, by the lack of engagement of key social actors in the design of conservation and development targets (Ban et al., 2013; Saarikoski et al., 2018). Moreover, conflicting interests between actors and asymmetric power relations, usually make conservation implementation difficult (Brockhaus et al.,

72 2014; Davies, 2001; Saarikoski et al., 2018). Understanding the social processes behind
73 collective actions (CA henceforth) is thus fundamental to sustain ecosystems (Ban et al.,
74 2013). A key component of these social processes is the social capital (SC henceforth)
75 of individuals and communities.

76 While SC means different things to different people (Dasgupta and Serageldin,
77 1999), it is broadly accepted that it refers to the aggregation of resources (actual or
78 potential) linked to the possession of a stable network of relationships of mutual
79 recognition (Bourdieu, 1980). That is, "the features of social organization, such as trust,
80 norms, and networks that can improve the efficiency of society by facilitating
81 coordinated actions" (Putnam, 1993; p.167). The SC concept has gained popularity due
82 to its accuracy to address complex theoretical and political issues, and has become a
83 cornerstone for sustainable development policies and nature's governance (Ballet et al.,
84 2007; guti, 1994; Pretty, 2003; Pretty and Ward, 2001). SC is fundamental to overcome
85 barriers to achieving mutually beneficial cooperative ways of meeting conservation
86 objectives (Bisung et al., 2014). SC has shown to be a key component of social CA
87 towards natural capital conservation and management (Ostrom, 1994; Pretty and Ward,
88 2001), where natural capital conservation and management stand for all activities
89 related to the protection, restoration, and management of natural resources (land, water)
90 and the environment.

91 CA towards natural capital conservation and management may consist of legal
92 demands, social demonstrations, press releases, or specific conservation practices,
93 whose implementation affects all the social actors involved (Ostrom, 2010). The
94 legitimacy, robustness, and effectiveness of conservation CA depend on an active social
95 learning process and institutional adaptability based on multiple types of knowledge
96 (Bennett et al., 2017) and the flow of information on the potential benefits of different
97 actions (Jackson and Yariv, 2011). However, strong motivation to act of a significant
98 number of people may not be materialized into CA due to a lack of information,
99 coordination, or access to specific resources (in Aldrich, 2011).

100 It is usually accepted that strong social ties at the community level facilitate CA and
101 governance around natural capital conservation and management (Gutiérrez et al., 2011;
102 Ostrom, 1994; Pretty, 2003; Pretty and Ward, 2001). These conditions could contribute
103 to building support for pro-environmental policies (Jones et al., 2012) and natural

104   resource management (Barnes-Mauthe et al., 2015). SC reduces transaction costs of

105   working together and facilitates cooperation (Pretty, 2003). Thus, people could have the

106   confidence to invest in CA, knowing that others will do so too. Coordinated CA can

107   improve the capture of ecosystem service flows (Barnaud et al., 2018). In turn, changes

108   in the ecosystems can have an impact on social links, by modifying human-nature

109   relations (Chan et al., 2012). For example, after a natural disaster, people could try to

110   improve their situation individually, breaking some bonds of reciprocity or, on the

111   contrary, could strengthen the cohesion of the group to improve the community

112   situation through CA (Hicks et al., 2009). These studies enhance the importance of SC

113   as a mediator and moderator of the impacts of hazardous events on communities.

114   Changes in ecosystems affect social actors. How stakeholders deal with these

115   changes varies according to their dependence on natural capital and their level of power

116   (Berbés-Blázquez et al., 2016). Dependence and power can modify the amount and type

117   of CA performed. This brings us to another debated issue, which lies in whose SC is

118   more critical in fostering CA (Ballet et al., 2007; Ishihara and Pascual, 2009; Pretty,

119   2003). The literature shows that collaborative and synergetic relationships are

120   developed among actors with common interests, contributing for example to the

121   development of SC between them and enhancing natural capital management

122   mechanisms (Brown, 1998; Folke et al., 2005; Naryan, 1999; Peluso, 2003; Plascencia,

123   2005).

124   Given the highly contextual nature of SC, to date, there is no consensus among social

125   scientists on a single methodology that encapsulates the diverse range of impacts

126   associated with SC (Sukhdev et al., 2018). Also, studies on the relationship between SC

127   and CA towards natural capital conservation and management still have some

128   limitations. They are mostly conducted within a community and rarely consider the

129   heterogeneity of social actors. On the other hand, they tend to address generic aspects

130   (e.g., climate change) or very particular situations, such as extreme events (e.g.,

131   hurricanes). In contrast, applications to problems of deforestation or agricultural

132   intensification are scarce.

133   We contribute to filling this gap by exploring the relationship between the SC and

134   CA towards natural capital conservation and management, from the organizational

135   perspective, across five case studies in Latin America. We used a structural equation

136 model to define the dimensions of SC and CA, which was used to measure the SC and
137 CA of the different social actors of the case studies. The case studies represent socio-
138 ecological systems with different degrees of rural landscape transformation: Valdivian
139 temperate rainforest in Panguipulli (southern Chile), Patagonian temperate forest in
140 Villa La Angostura (southwestern Argentina), Atlantic subtropical rainforest in Puerto
141 Piray (northeastern Argentina), Chaco subtropical dry forest in Santiago del Estero
142 (northwestern Argentina) and Pampean temperate grasslands in Balcarce (central
143 Argentina).

1.1. Theoretical grounding

1.1.1. SC concept

146 Two centuries ago, economists, politicians, and philosophers related the SC concept
147 with corporations and cooperatives as facilitators of business (Sukhdev et al., 2018). In
148 the 1980s, SC was seen as a resource of individuals, which arises through their
149 interaction with others in formal and informal structures (Bourdieu, 1985; Coleman,
150 1988). Bourdieu defined SC as "the aggregate of the actual or potential resources which
151 are linked to possession of a durable network of more or less institutionalized
152 relationships of mutual acquaintance or recognition" (Bourdieu, 1985, p.   248). He
153 considered it one of the four forms of capital, along with economic, cultural, and
154 symbolic capital, which are unequally distributed in society (Aldrich et al., 2018). For
155 Bourdieu, SC can provide access to some benefits due to social ties and contribute to
156 offset certain inequalities concerning other capitals.

157 Coleman incorporated into the dimensions of the SC the obligations and
158 expectations, informational potential, practical norms and sanctions, authority relations,
159 and appropriate social organizations (Coleman, 1988). SC could help human capital
160 development and generate other benefits, such as organizational productivity, because
161 of greater trust among individuals.

162 In the 1990s, Putman popularized the concept, considered as "the features of social
163 organizations, such as networks, norms, and trust, which facilitate action and
164 cooperation for mutual benefit" (Putnam, 1993, p. 35). He focused on seeing how
165 people within a group work together toward shared goals. The critical point is trust,
166 which facilitates the participation and cooperation to coordinate actions between

167 members in pursuit of a common objective, generating feelings of reciprocity and
168 strengthening network cohesion.

169   SC could be separated into two related components, structural and normative (in
170 Nenadovic and Epstein, 2016). The structural component of SC refers to social network
171 relationships among actors within a given system and comprises three types: bonding,
172 bridging and linking SC (MacGillivray, 2018). Bonding SC refers to the internal ties
173 among relatively homogeneous individuals within the same community or group.
174 Therefore, these close relationships result in strong social support and in-group attitudes
175 (in Aldrich, 2011). Bridging SC refers to the relationship with external members from
176 communities or groups. Therefore, ties are weaker than in bonding SC but could open
177 access to some benefits, such as getting a job or reducing social conflicts. Linking SC
178 connects people of different levels of authority and power, unlike the previous ones that
179 entitle horizontal relationships (Evans and Syrett, 2007; Ishihara and Pascual, 2009),
180 allowing people to access resources that could not find alone or by mobilizing the other
181 two types of SC.

182   The list of normative components of SC has increased over time and is also classified
183 according to the three types of structural components (Nenadovic and Epstein, 2016).
184 Different authors describe at least six different components to consider: participation,
185 trust, cooperation, reciprocity, network cohesion, and awareness (Adger, 2003; Durston,
186 2005; Grootaert and Bastelaer, 2001; Lin, 1999; Pretty, 2003; Pretty and Ward, 2001;
187 Sabatini, 2006; Uphoff, 2000). Participation is understood as the social interaction
188 through groups, when they are conscious of it and when doing so could improve their
189 well-being (Lin, 1999). Trust is to have the security that the group will work as desired,
190 as well as to self-confidence in dealing with the others (Pretty, 2003; Pretty and Ward,
191 2001). Cooperation refers to the mutually beneficial collective interactions aimed at
192 achieving shared objectives (Durston, 2005; Uphoff, 2000). Reciprocity is the exchange
193 of goods and information among social actors, to ensure that trust and cooperation are
194 maintained over time (Pretty, 2003; Pretty and Ward, 2001). The networks' cohesion is
195 the sense of unity presented by the different social groups or actors and which can favor
196 mutual social support (Grootaert and Bastelaer, 2001; Martí, J., Bolíbar, M., & Lozares,
197 2017; Sabatini, 2006). Awareness, less frequently considered, is how conscious a group
198 is about a situation (Adger, 2003). However, it is not clear whether all these components
199 add equal weight to the SC or whether there is a more important one.

1.1.2. CA concept

Diverse social sciences (e.g., anthropology and psychology) studied how societies choose to allocate scarce resources in the face of limited information and uncertain futures. Different theories have tried to answer questions about why specific actions are made, who is involved, among others (Adger, 2010). CA could be broadly defined as an "action taken by a group [...] in pursuit of members' perceived shared interests" (Scott and Marshall, 2009: 96). In the context of natural resources, CA refers to the shared benefits and costs of the activities undertaken for conserving and managing natural resources (Ostrom, 1994).

In this study, we consider CA as a voluntary process of cooperation among various stakeholders addressing some kind of action towards natural capital conservation and management in a given territory. However, CA could be counterbalanced by power asymmetries and conflicts of interest, in which case trust-building and cooperation are needed to achieve mutual goals and resolve conflicts (Barnaud et al., 2018). The scale-dependent, geographic extent, and placed-dependent nature of SC could be playing a key role in the development of CA (MacGillivray, 2018). Other aspects of the context (for example, democracy, security, etc.) could also influence the realization of these actions (Adger, 2010).

Analyzing CA allows us to understand the strategies displayed by different actors in specific fields (Pinedo, 2006). First, it is necessary to analyze the collective identity, thus observing "the capacity of the actors to be defined according to their expectations and capacity for action" (Melucci, 1994). Second, it is necessary to observe the influence of social organizations in the facing of environmental problems. This influence can be measured through the number of actions they undertake, their perceived gain in visibility and achievement of those actions, the impacts on other organizations derived from those actions, and the perception of general improvement. Thirdly, it is also required to observe all kinds of actions that organizations could have undertaken, not only those related to specific conservation practices but also legal demands, social demonstrations, or press releases (Ostrom, 2010).

1.1.3. SC and the emergence of CA towards natural capital conservation and management

233 The analysis of the CA requires understanding the social system; the concrete action
234 that is pursued, the conflict that the action originates, the identity of the social actors
235 involved, and their shared objectives (Castells, 2003; Tarrés, 1992). The accumulation
236 of SC in different actors (e.g., small farmers) can promote the emergence of shared
237 goals related to sustainability (Marín et al., 2012). The SC can increase the provision of
238 information, mutual aid, and social actors' participation to address environmental
239 problems (Aldrich et al., 2018; Gutiérrez et al., 2011; Pretty and Smith, 2004; Uphoff,
240 2000). In this way, networks between different sectors and scales can be connected,
241 facilitating the appearance of CA. These sectors include private social actors,
242 government institutions, and other groups, who make up the mechanisms that structure
243 policies, legislation, or CA (Aldrich et al., 2018). Creating an environment in which the
244 generation of SC is encouraged may help local governments to achieve their desired
245 policy goals for sustainable development. Besides, SC could have a primary role for
246 vulnerable actors to "compensate" the significant influence of dominant ones.

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248   1.2. Conceptual framework proposed

249 From the above, we can highlight some conceptual relations between SC and CA that
250 have not been explored in depth, considering their different dimensions and the
251 heterogeneity of social actors within and across social-ecological systems (Figure 1).
252 Based on these relationships, we propose that: (1) Higher levels of SC are related to a
253 higher number of CA undertaken concerning natural capital conservation and
254 management; (2) Vulnerable actors have a higher SC and engage in more CA, given
255 their level of dependency on natural capital. Vulnerable actors may seek to improve
256 their situation through building SC, given the lack of other resources; (3) Social actors
257 with higher levels of internal and external SC can better counterbalance adverse
258 conditions through CA, as compared to actors who only have internal SC.
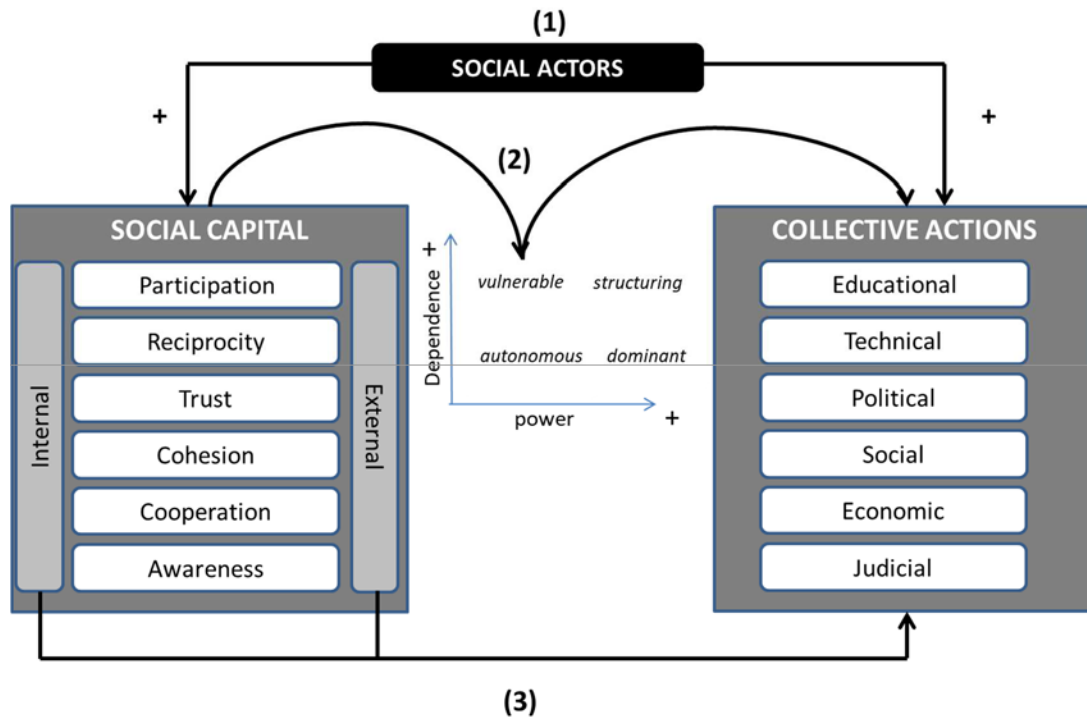
Figure 1. Conceptual framework: relations between SC and CA, considering their different dimensions and the heterogeneity of social actors.

2. Methods

We selected five case studies, which correspond to long-term research study areas for which environmental and social diagnosis were available. We designed and applied a questionnaire to measure the SC of the different organizations (social actors) and environment-related CA undertaken by them. The methodological steps (Figure 2) are described in the following subsections.

Case studies and interviewee's selection
1. Case studies description
2. Social actors analysis
3. Interviewees selection

Interview design and application
4. Social capital operationalization
5. Questionnaire preparation and data collection

Relationships evaluation
6. Social capital and collective action model fitting
Exploratory Factor Analysis (EFA)
Confirmatory Factor Analysis (CFA)
7. Information analysis (relations between social capital and collective actions, for different types social actors)

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Figure 2. Steps followed in the methodology.

2.1. Case studies and interviewee's selection (step 1, 2 and 3)

The case studies comprised different biophysical and socioeconomic contexts; these territories have faced different environmental and social problems related to natural resources use, access, and management (Supplementary Material 1). In Panguipulli Municipality, southern Chile, forest degradation (the passage from old-growth to degraded secondary forest or from secondary forest to shrubland) is one the main threats to the natural capital. In Villa La Angostura locality, deforestation due to real estate development, was among the problems identified. In Balcarce Municipality, the loss of grazing lands and intensification in land use due to soybean expansion is a primary concern. In Puerto Piray Municipality, deforestation and land-use intensification due to agriculture and forestry, and land concentration in few owners is a prevalent problem. In Santiago del Estero, forest clearing for soybean and pasture cultivation and land degradation due to overgrazing, and well as the displacement of native people are central concerns. For these case studies, we expected varied expressions of CA and the presence of different types of organizations undertaking them.

The selection of organizations relied on actor's maps that were available to us for each case study, which were built on an expert-criteria basis (Reed et al., 2009). Thus,

the different organizations (social actors) present in each case study were defined as units of analysis, whereas the observation units were the interviewed members of these organizations. The mapping of actors relied on a power-dependence matrix since our interest was to select units of observation in a gradient of power and dependency. This 'structural' type methodological tool allows a precise observation of the social relations that occur in an area, being useful to identify the power social actors have to generate changes, or the lack of power, which places them in a more vulnerable situation concerning resources access (Guedes et al., 2006; Tapella, 2007). Power is defined here as the capacity to generate changes and carry out actions that affect the conservation of the ecosystem (positively or negatively), whereasdependence is defined as the need and reliance of social actors on natural capital conservation. According to power-dependence matrix social actors were classified in the following 4 types: (1) dominant, with high dependency and high power; (2) vulnerable, with high dependency and low power; (3) structuring, who have low dependency and high power; and (4) autonomous, who have low dependency and low power.

Interviewees were selected to account for: i) two organizations of each type of social actor, from which three persons were to be selected; ii) representation of the public, private and civil society sectors; iii) sdifferent degree of leadership and responsibility within their organization (Table 1).

Table 1. People and organization interviewees.

Interviewee information/ Case studies		Villa La Angostura	Balcarce	Panguipulli	Puerto Piray	Santiago del Estero
Number of people interviewed		12	18	18	18	18
Average age		50	55	48	40	46
Gender (Female/male)		1/11	5/13	7/11	4/14	3/15
Number of organizations		6	6	12	6	14
Type of organization	Public	2	2	7	3	5
	Private	3	2	2	2	2
	NGO'S	1	2	3	1	7
Type of social actor	Dominant	2	2	4	2	4
	Vulnerable	2	2	1	2	6
	Structuring	-	2	3	2	4
	Autonomous	2	-	4	-	-

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2.2. Interview design and application (step 4 and 5)

Information on SC and CA was collected between July and August of 2017 through semi-structured interviews applied to 84 persons from 44 organizations. The interview had five sections: personal characteristics (age, gender, ethnicity, educational level, among others), characteristics of the organization (origins and development; number of members), dimensions of the SC (see Figure 3), CA developed, and relationships among social actors (type of relationship -collaboration or conflict-, type of interaction -for example, technical, economic-, motivation to cooperate -for example, obligation, solidarity-). Most of the questions were closed, but a few were open, regarding organization characteristics (e.g., constitution date of the organization), and awareness (e.g., the main environmental problem of the area). Open answers were categorized according to thematic criteria (e.g., for the constitution date of the organization, the categories were: less than five years, between five and ten years and more than ten years).

The SC concept was operationalized through six dimensions (see Conceptual Framework and Figure 3), defined through different measurable affirmations. The internal and external SC was evaluated using different affirmations regarding the characteristics of the organization (internal SC), and relative to the relationship with other organizations (external SC). A Likert scale was used with five levels, ranging from "totally disagree" to "totally agree," to measure the level of agreement on these affirmations. To operationalize CA, each interviewee was asked to list those activities carried out by their organization. They were also asked the date of these actions, their frequency, and their effectiveness (measured with Likert from "very little effective" to "very effective").

336   Figure 3. The six dimensions of SC, their definition, and affirmations used as observable variables. Green boxes represent the affirmations and

337   codes related to internal SC (bonding SC), and blue boxes represent those related to external SC (bridging SC and linking SC).

DIMENSION	DEFINITION	REFERENCES	AFFIRMATION	CODE
PARTICIPATION	Social interaction through groups, when they are conscious of it. Participation could provide access to some resource that would eventually improve wellbeing	Lin, 1999	When we make decisions it is common for most of the members of the group to participate	PARTIC_RA1
			When we do activities within the group, it is common that majority of members participate	PARTIC_RA2
			It is common for my organization to participate in joint activities with other organizations	PARTIC_ER1
TRUST	Security that the group will work as desired, as well as to self-confidence or familiarity in dealing with the other person/organization	Pretty, 2003; Pretty and Ward, 2001	The group works as I hope it works	CONFI_RA1
			I can talk honestly with the other members of the group	CONFI_RA2
			We work in a cordial way with other organizations / institutions	CONFI_ER1
			If the group has a problem, we turn to the judicial system because we believe it will solve it	CONFI_ER2
			We turn to the municipal government because we believe it will meet our demands	CONFI_ER3
			We have a high level of trust in the provincial government	CONFI_ER4
			We have a high level of trust in the national government	CONFI_ER5
COOPERATION	Mutually beneficial collective interactions or actions aimed at achieving shared objectives, which could have different motivations	Durston, 2005; Molyneux, 2002; Uphoff, 1999	We all work to achieve the goals and objectives of the group	COOP_RA1
			We usually divide the tasks within the group	COOP_RA2
			When we work with other organizations it is common to reach the goals we set ourselves	COOP_ER1
RECIPROCITY	Exchanges of goods or information, whose purpose is to build and strengthen ties of long-term social relationships, frequently based on favors and gifts	Pretty, 2003; Pretty and Ward, 2001	It is common for us to do favors within the group	RECIP_RA1
			When I do a favor to another member, I know it will be returned when I need it	RECIP_RA2
			Our organization provides a lot of collaboration to other organizations	RECIP_ER1
			Our organization receives a lot of collaboration from other organizations	RECIP_ER2
NETWORK COHESION	Sense of unity or connection of groups. The sense of belonging or the degree of members consensus that make the group a single entity	Sabatini, 2006; Grootaert and Bastelaer, 2001; Pretty and Ward, 2001	We share the same values with the members of the group	COHES_RA1
			I share the norms of the organization	COHES_RA2
			It is common that we achieve consensus when making decisions within the group	COHES_RA3
			I feel that we share the same values with the members of the other organizations	COHES_ER1
			It is common that we achieve consensus when coordinating with other organizations	COHES_ER2
AWARENESS	Represents how conscious a group is about a situation. It includes the actor's perspective on the problem	Adger, 2003	The [*main threat to natural capital of each group*] is the main problem of the rural area	CONSC_RA1
			The majority of the members of the organization is involved in the resolution of this problem	CONSC_RA2

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2.3. Relationships evaluation (step 6 and 7)

A structural equation model (SEM) was used to explore which of the defined dimensions were most important to describe the SC concept. A SEM combines factorial analysis and regression analysis. A SEM allows elaborating, from latent variables (dimensions), and observable variables (affirmations), theoretical constructions on a particular concept. We used the information from all interviewees and study cases in order to obtain a model that explains the components of SC and then calculate SC as a function of the weighted affirmations. All the affirmations of the six dimensions of the SC (Figure 3) were initially taken into account to estimate the model.

The reliability of the affirmations to explain the SC was analyzed through an exploratory factorial analysis (EFA), carried out in version 23 of the SPSS software (IBM Corp. Released in 2016. IBM SPSS Statistics for Windows, version 24.0. Armonk, NY: IBM Corp.). We investigated whether each SC dimension was correctly defined by the selected affirmation (Batista-foguet et al., 2004; Verdugo et al., 2008).

Using a confirmatory factorial analysis (CFA) performed on version 21 of the AMOS software (Arbuckle, 2014), we analyzed how the affirmations and dimensions that explained the SC were related to each other and to what extent they explained the SC of the actors (Blanco and Díaz, 2005). Based on R^2 and standardized regression weights (B), we selected the best model (Schumacker and Lomax, 2010). With the best model selected, a SC value (internal and external) was calculated for each social actor (organizations). In order to characterize the SC of each case study, the individual results of each social actor were pondered.

An EFA was conducted to analyze which questions were relevant for defining CA. We considered the number of actions that each social actor stated, their perception regarding the increase in visibility due to these actions, the effects of these actions on other organizations, and the positive environmental changes achieved through these actions. The relevant questions, according to the EFA, were used to measure the level of actions in each case study. The details of the indicators and tests used in this step are presented in Supplementary Material 2 (for SC) and 3 (for CA).

The affirmations discriminated by the most appropriate models were used to measure SC and the CA levels of the 44 organizations. Since more than one person was interviewed from each organization, when the analysis was carried out at the level of the organization the

responses of the different interviewees were averaged (the standard deviation within organizations was 0.6). The information for each dimension of each social actor was weighted with the standardized regression weights (B) of each affirmation and each dimension of SC, and for CA, with the factor load of each item obtained from the EFA component matrix.

The results obtained from the application of SC models and CA were normalized (0 to 1). The results were grouped by type of social actor, averaging their SC level. After grouping, the relationships between SC and CA for each case study were explored through different analyses. First, a biplot graphically explored SC and CA. Second, the SC and different characteristics of the organization (the type of social actor, type of organization, legal status, geographical scope, constitution date, motivation for creation) were analyzed by boxplot graphs and the ANOVA test. Third, SC, CA, and three concepts that could help understand the link between them, such as involvement, awareness, and the number of relationships with other social actors, were analyzed by the Pearson correlation. In addition, a qualitative analysis was conducted to group the CA in categories, such as educational, political, or social actions.

3. Results

3.1. The social capital concept and its measurement

The model with the best fit (Figure 4) obtained through the EFA and CFA (details in Supplementary Material 2.B) was used to quantify the SC in the five case studies. The SC was composed of an external component (standardized regression weights B=0.50) and an internal one (B=0.68). External SC (bridging SC) was better explained by cooperation (B=1) than cohesion (B=0.78). External cooperation included affirmations referred to working together and collaboration between organizations, whereas external cohesion included affirmations related to sharing values with other organizations and obtaining a consensus among them. Internal SC (bonding SC) was better explained by cooperation (B=0.81) and cohesion (B=0.79) than participation (B=0.76). The internal cooperation referred to the separation of tasks for the achievement of a common goal. Internal participation referred to members' participation in the organization's decisions and activities, and internal cohesion referred to their shared values and the reciprocity among its members. R^2 values in each dimension of SC

402 (numbers in parenthesis within the grey rectangles on the right) suggest that these affirmations

403 were reasonably good measures of the latent variables.
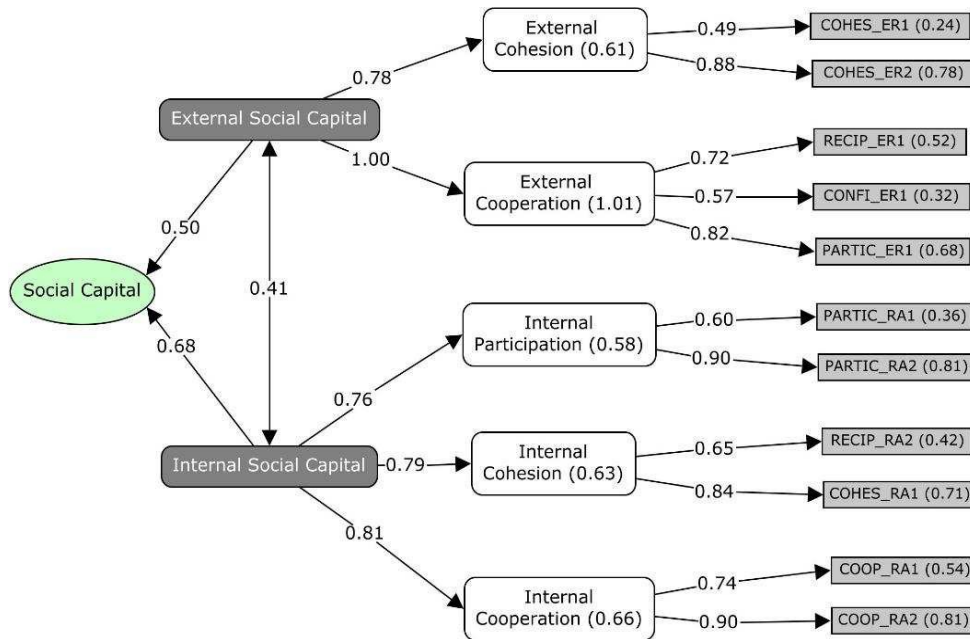
404

405 Figure 4.   Model of SC composed of different dimensions (graphical output of the
406 standardized estimates for the best-fit model). The numbers in the arrows are the standardized
407 regression weights (B). Codes (in grey and black font) represent the affirmations considered
408 for each dimension and are followed (in parenthesis) by the R^2 coefficients; those ending in
409 ER were questions related to external SC, and those ending in AR were related to internal SC.
410 See definition of codes in Figure 3.

411 The case studies did not show notorious differences in SC (Figure 5). Balcarce attained a
412 higher value of total SC, followed by Puerto Piray and Santiago del Estero. The latter had a
413 higher level of internal SC. However, the lowest level of external SC, while Villa La
414 Angostura had the lowest level of internal SC. Panguipulli, had a similar value for both types
415 of SC. External SC was lower than internal SC in all case studies, except in Villa La
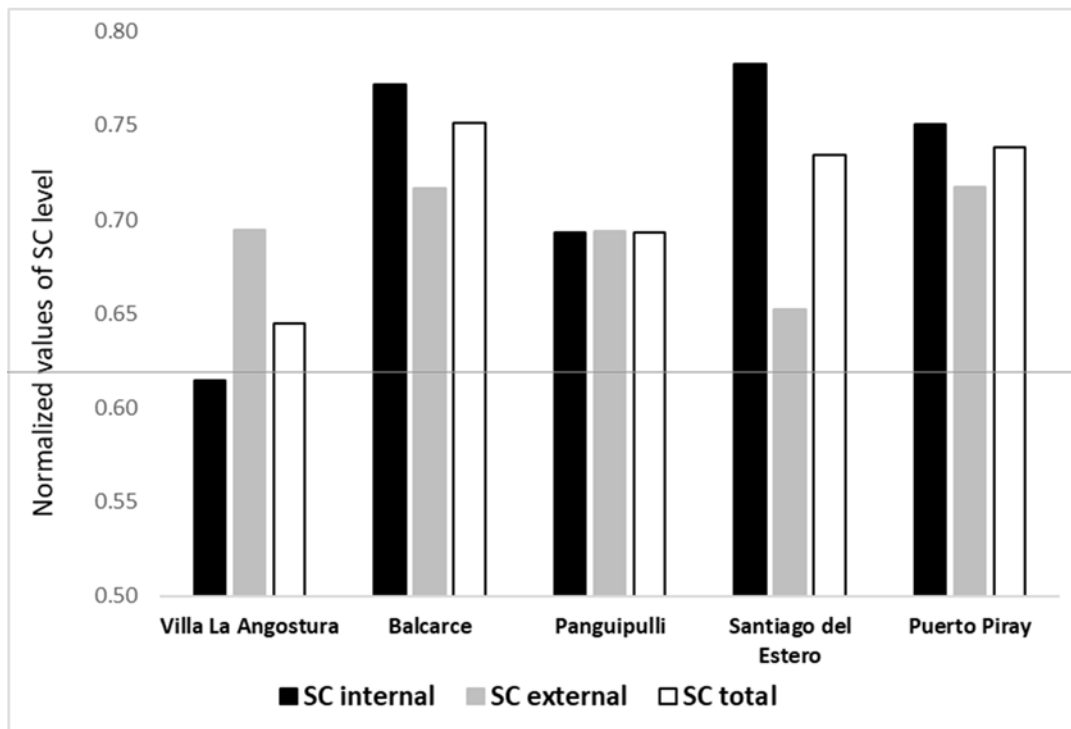416 Angostura.

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Figure 5. Internal, external, and total social capital (SC) scores for the different case studies.

Some other relations among different organization characteristics and SC were found (see details in Supplementary Material 4). Legal status was significantly related to SC ($p < 0.05$). The formal legal status appears to be relevant at the time of generating or maintaining the SC, the same as the internal motivation for creation, although the newest organizations had higher SC than older. The type of organizations with the highest SC were NGOs and public organizations. The structuring and dominant social actors presented higher SC as well as the international organizations.

3.2. Main environmental problems and related collective actions

The main environmental problems identified by interviewees varied widely. In Panguipulli, people mentioned access to drinking water, but also the presence of trash. In Balcarce, excessive use of agrochemicals was the most mentioned, and their impact on the degradation of natural resources. In Villa La Angostura, deforestation prevailed, but also the lack of urban planning. In Santiago del Estero, most of the interviewees mentioned excessive fumigations and forest clearing. This issue was also mentioned in Puerto Piray, where deforestation and forest degradation predominated.

440   In general, for all types of actors, and all case studies, the CA level was low (Table 2). The
441   affirmations included in the best model for measuring CA were: a) if the interviewee had
442   participated in CA, b) the number of CA carried out, c) if the interviewee perceived greater
443   visibility and achievements, and d) if the interviewee considered that the environmental
444   problem improved.

445   The primary type of CA was the social action (e.g., commissions or assembly's creation) or
446   other community interventions (e.g., ceremonies to bring water or collecting signatures).
447   Educational/technical activities were also relevant, especially courses and workshops, and
448   political actions, relative to plans, programs, projects, and agreements. To a lesser extent,
449   there were complaints, demands, and intimations (judicial actions) and the creation of
450   cooperatives, fairs, and productive projects (economic activities). The social actors across
451   study cases also differed in the types of CA. The structuring social actors had carried out more
452   actions, especially educational/technical ones, followed by the vulnerable actors, who had
453   mostly engaged in social actions and were the only ones that had pursued economic activities
454   and most of the judicial actions. The dominant actors had carried out more political and
455   educational/technical actions, and the autonomous actors had engaged in political and social
456   actions.

457   The predominant type of activities at each study cases also varied. In Villa La Angostura
458   and Puerto Piray, social actions predominated followed by political ones while, in Santiago
459   del Estero, the most significant actions were social and educational/technical actions. In
460   Balcarce and Panguipulli, the actors had undertaken more judicial actions, whereas, in Puerto
461   Piray, economic actions prevailed.

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465   Table 2. Summary of the collective actions undertaken in the five study cases, by type of social actor, grouped in educational/technical,

466   political, social, economic, and judicial.

Collective action type/Study case; Social actor type	EDUCATIONAL/TECHNICAL			POLITICAL			SOCIAL				ECONOMIC	JUDICIAL	TOTAL
	Courses and workshops	Professional journeys and advice	Research and extension	Plans, programs, and projects	Interjurisdictional and labor union agreements	Regulations and laws	Commission and assemblies	Manifestations and protests	Communications in the media	Other community interventions	Cooperatives, fairs, and productive projects	Complaints, demands, and intimations	
Villa La Angostura	1 (6%)			2 (11%)	3 (17%)	1 (6%)	1 (6%)	1 (6%)	2 (11%)	6 (33%)		1 (6%)	18
Balcarce	9 (38%)	1 (4%)	2 (8%)	3 (13%)	2 (8%)	2 (8%)	2 (8%)					3 (13%)	24
Panguipulli	8 (35%)		1 (4%)	4 (17%)	1 (4%)	1 (4%)	4 (17%)	2 (9%)	1 (4%)	1 (4%)			23
Santiago del Estero	3 (16%)	3 (16%)		1 (5%)	2 (11%)	2 (11%)			1 (5%)	5 (26%)	1 (5%)	1 (5%)	19
Puerto Piray	1 (4%)	2 (8%)		1 (4%)	4 (15%)	2 (8%)	2 (8%)	2 (8%)	2 (8%)	4 (15%)	4 (15%)	2 (8%)	26
Dominant	6 (25%)	1 (4%)	1 (4%)	4 (17%)	4 (17%)	1 (4%)	1 (4%)	1 (4%)	2 (8%)	1 (4%)		2 (8%)	24
Structuring	10 (27%)	5 (14%)	2 (5%)	3 (8%)	4 (11%)	3 (8%)	2 (5%)	1 (3%)	2 (5%)	5 (14%)			37
Autonomous	4 (25%)			2 (13%)	3 (19%)	2 (13%)	1 (6%)			4 (25%)			16
Vulnerable	2 (6%)			2 (6%)	1 (3%)	2 (6%)	5 (15%)	3 (9%)	2 (6%)	6 (18%)	5 (15%)	5 (15%)	33
Total	22 (22%)	6 (5%)	3 (3%)	11 (10%)	12 (11%)	8 (7%)	9 (8%)	5 (5%)	6 (5%)	16 (15%)	5 (5%)	7 (6%)	110

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3.3 Relation between SC and CA

The social actors with the highest SC performed more CA (Figure 6). Panguipulli had the most evident positive relation between the two variables, showing that social actors with low SC had a medium level of actions, and those with high SC had a higher level of actions. Balcarce, instead, had high levels of SC, but a medium level of actions, which was higher for structuring actors. On the other hand, Villa La Angostura and Puerto Piray had a higher level of actions, regardless of the level of SC and type of social actor or organization. In Santiago del Estero, the ones who carried out actions were those with a high level of SC (public sector and NGOs), but it is the case with the lowest engagement in collective actions, regardless of the actor type.
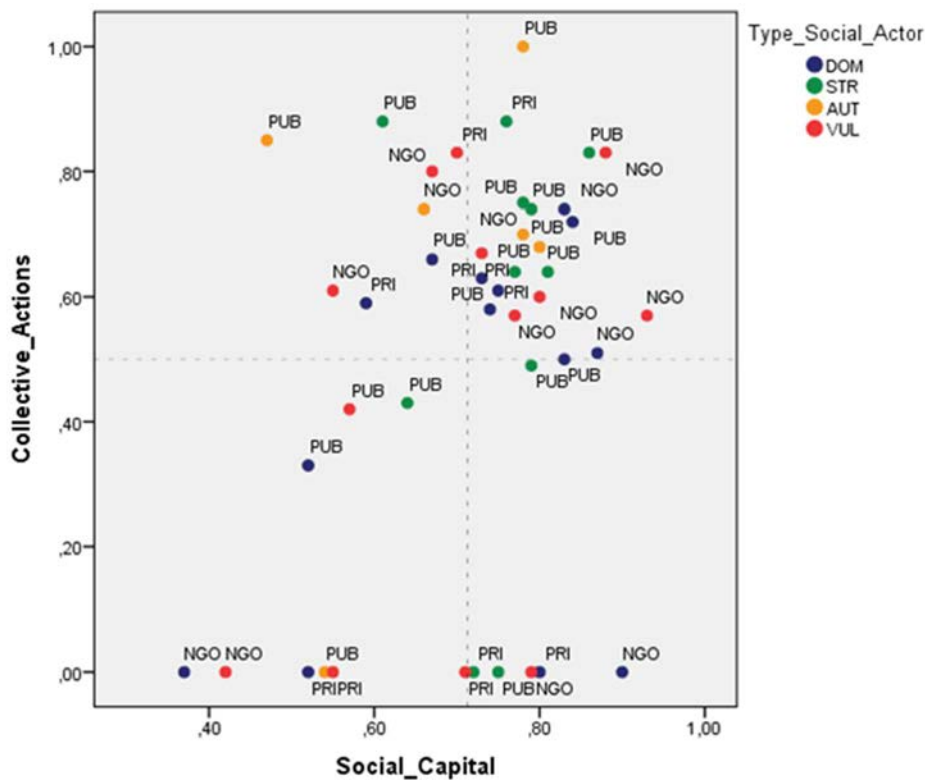
Figure 6. Biplot of SC and collective actions for all case studies showed by type of social actor (dot's color: DOM: Dominant; STR: Structuring; AUT: Autonomous; VUL: Vulnerable) and the type of organization (dot's name: PUB: Public, PRI: Private or NGO: nongovernmental organization). As there were no results lower than 0.4 for the SC, the scale goes from 0.4 to 1 for better visualization; dotted lines indicate the means of the obtained values.

491 Those social actors who had a more similar level of internal and external SC, that is, that
492 the absolute value of the difference between one and the other was smaller had higher levels
493 of CA (Supplementary Material 5). On the other hand, the Pearson correlations showed that
494 CA was linked to other variables, such as awareness ($p<0.01$), involvement ($p<0.01$), and the
495 number of relationships with other social actors ($p<0.01$). Being awareness also correlated
496 with involvement ($p<0.01$) and the number of relationships ($p<0.05$) (Supplementary Material
497 6).

498 As the coefficients in Table 3 show, SC was generally high in most case studies and more
499 significant for dominant and structuring social actors. Contrary to our initial assertions, in
500 most cases, the vulnerable actors were those with the lowest SC, except in Villa La
501 Angostura. In three case studies, the level of CA was higher for those social actors with high
502 power, and lower for vulnerable ones, with the opposite occurring in Puerto Piray.

503 When we consider the total level of SC of all types of actors, Balcarce had a higher level of
504 SC and CA in line with our initial declarations, followed by Puerto Piray. On the other hand,
505 Santiago del Estero had a high level of SC, but the lowest level of CA and, on the contrary,
506 Villa La Angostura had a low SC but more actions (above the mean).

507

508 Table 3. Social capital and collective action levels (normalized values on a scale from 0 to
509 1 for each concept) for each type of social actor (DOM: Dominant; STR: Structuring; AUT:
510 Autonomous; VUL: Vulnerable).

Case studies/ Type of social actor	Social capital					Collective actions				
	DOM	STR	AUT	VUL	Total	DOM	STR	AUT	VUL	Total
Villa La Angostura	0.56	-	0.62	0.75	0.64	0.12		0.37	0.25	0.24
Balcarce	0.80	0.78		0.68	0.75	0.26	0.32		0.24	0.28
Panguipulli	0.70	0.71	0.70	0.57	0.69	0.23	0.15	0.21	0.16	0.20
Santiago del Estero	0.74	0.75		0.72	0.73	0.1	0.22		0.09	0.13
Puerto Piray	0.74	0.79		0.69	0.74	0.13	0.25		0.32	0.24

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4. Discussion and conclusions

The results of our study reaffirm the following: i) the multidimensional nature and complexity of SC; ii) Higher levels of SC are related to higher levels of CA; iii) social actors with developed internal and external SC can better counter adverse conditions through CA compared to actors who only have one type of SC; iv) vulnerable social actors do not necessarily have a higher SC or engage in more CA, despite their higher dependence on natural resources; v) those who hold more power or influence in the territory, have higher levels of SC and CA; vi) vulnerable actors often carry out social, economic and judicial actions, while dominant and structuring actors carry out more educational/technical and political actions.

The modeling results corroborate that not all theoretical dimensions originally proposed based on the literature (Figure 3) are equally important in determining the levels of SC. The external SC (bridging SC) is better explained by cooperation and cohesion, while internal SC (bonding SC) is better explained by cooperation, cohesion, and participation. These results reaffirm the multidimensional nature and complexity of SC (Nenadovic and Epstein, 2016) but differ from other studies that report trust and community participation as relevant components of external and internal SC (Barnes-Mauthe et al., 2015; Evans and Syrett, 2007).

Dominant actors tend to exhibit higher levels of SC, in coincidence with previous findings (Evans and Syrett, 2007; Jones et al., 2012). This is due to their higher level of internal and external SC. On the contrary, the vulnerable actors in all cases, except Villa La Angostura, exhibit the lowest levels of both types of SC. The variables that explain this are, among others, low cohesion and external cooperation, as well as low participation in internal and external activities of the organization. This can lead to the disappearance or the significant weakening of the organizations and, therefore, the loss of CA. There is evidence that the loss of local institutions has caused or aggravated environmental problems, as occurred in many of the case studies and other areas of Argentina (Cáceres, 2015). This evidence shows that the disappearance of small producers in the countryside can lead to the loss of their representation. This loss may leave a void that facilitates the advance of deforestation or land-use intensification (Pretty and Ward, 2001).

Therefore, a synergistic relationship exists between the level of power and SC. The more power actors hold, the more successful their organizations tend to be in achieving specific

CA, which strengthens their trust and cooperation, thus maintaining or increasing their SC over time. Not only SC has a crucial role in CA, but also the type of CA carried on depends on the type of SC the actors have (Nenadovic and Epstein, 2016). The opposite occurs in organizations that congregate individuals with low power and high dependence on natural capital. In these cases, the difficulty of the CA and the scope of significant achievements can erode their SC. This remarks the need to support and empower these actors (Evans and Syrett, 2007; Pretty and Ward, 2001), which is precisely the role that environmental NGOs and human rights organizations have taken in the Latin American territories in general, and our case studies in particular. However, CA is not always related to the maintenance of natural capital. On the contrary, in the cases analyzed, several actors with higher power use their internal SC to transform natural capital negatively (e.g., rural society, large forestry companies).

The latter could be related to what some authors named the "dark side" of SC, that is, when it is used negatively, for example, for exclusion, hoarding of resources, or even group violence (Aldrich, 2011; Aldrich et al., 2018; MacGillivray, 2018). For example, the restrictive nature of networks may lead to loss of freedoms for their members by doing the act even without being convinced of the action, in order to remain part of the group (in Sukhdev et al., 2018). It also could be used to curb laws that favor the common good or exclude certain vulnerable actors and, consequently, increase inequality (Aldrich et al., 2018). Therefore, when analyzing SC, it is necessary to understand the cultural characteristics of social actors with particular attention to the power relations between social actors and their heterogeneity.

Although a marked pattern SC-CA was not found, we can order the results under four possible combinations :

High SC-High CA: this combination is what we would have expected according to what most SC and conservation literature proposes. However, in this study, this relationship occurs only in some cases, when dominant and structuring actors (e.g., agricultural technology institutions, local parliaments), based on their high SC, generate and engage in a significant number of actions. In addition, they perceive their actions as successful, which in turn reinforces their SC.

Low SC-Low CA: This situation reflects the other extreme. In this case, a not so good relationship may occur, where a decreasing SC leads to low engagement and little effectiveness of the actions, which erodes the SC in a spiral that can end in the dissolution of

the organizations. This combination reflects the reality of local public institutions (e.g., Municipalities) and others that are fighting for their subsistence (e.g., peasant organizations). It could be due to very asymmetrical situations where one single powerful actor with high SC influences conservation (e.g., large protected areas in Panguipulli), despite total SC and CA are low. This is the least desired situation. On the other hand, it could be the case when organizations are fragile, and their actions are focused on achieving subsistence, as it happened in some local organizations in Santiago del Estero.

High SC-Low CA: This combination rarely occurs with actors who do not have a direct interest in the problem (e.g., Ministry of Production) or are causing the problem (e.g., a large forestry company, rural society). That is, a high level of SC does not translate to a high level of CA, for example, when dominant social actors use their power to suppress the intention of CA of other actors to improve natural capital. Given that the problem is not yet visible, even when there are actors with a high SC, no conservation actions are carried out; or, on the contrary, the loss of natural capital is so significant that the SC does not result in actions capable of reversing this situation. Some NGOs of Santiago del Estero reflect this situation, generally with more internal SC.

Low SC-High CA: This situation is rare and is the case of some organizations that, although having a low SC, are very affected by the problem, which leads them to get involved in specific actions, as it happened with the Forestry Department of Villa La Angostura. It could be the case of vulnerable actors (e.g., peasant movements, neighborhood organizations) with less power, who generate higher actions given their dependence on natural capital. Some have higher power than others, given their position within the State or the infrastructure they deploy (e.g., National parks administration). It could be the case of dominant actors with a high level of SC that made CA, even though the SC level is low. It could also be the case of organizations that have a long time on the territory and may have suffered a SC leak, but that act against the problems, as some environmental NGOs of Puerto Piray show. Sometimes, actors do not assume the cost of participating in groups or getting involved in activities to maintain SC since they would still benefit from the effects generated by the CA carried out by others (Aldrich, 2011; Ostrom, 1994).

These combinations could not reflect some situations, such as the following: a) although vulnerable actors exhibit less SC and a low level of collective actions on average, they carry out more collective judicial and economic actions, which have an impact on the territory on the short-term; b) there is a high percentage of technical/educational actions, whose results are

seen in the longer term, and social actions, which in many cases serve to disseminate negative implications of the problem.

Therefore, it is important to understand the nature or type of CA and the temporal dynamics of CA. They may be less variable, but they are systematic, and they respond to the priorities of the social actors in a given space and time. Under conflict situations, legal actions may be carried out, while in moments of specific stability, the actions that predominate may be fewer and of another type.

The results reflect the heterogeneity of environmental issues that affect South American territories and how, in some cases, SC has contributed to CA. Nevertheless, they also reveal the need to restore the rules of access to natural resources that are finally those that empower certain individual actors, who are ultimately determining the environmental dynamics of the territories.

The formation and maintenance of SC of the most vulnerable actors and those who support them must be a priority for political action, in order to counteract the asymmetric power relations that lead to the exclusion and marginalization of many rural actors.

Finally, we acknowledge some methodological limitations. The interpretation of the relative weight of the affirmations within the SC measurement or of why some affirmations are not significant is challenging, and different explanations can be offered based on the results. Firstly, some components are easier to identify by the interviewee, and/or how the components are presented in the questionnaire promotes a more homogeneous understanding, resulting in similar answers. Secondly, people can give politically correct answers to specific questions related to the components of SC, such as trust or cooperation, which could bias the measurement and the significance of SC components. Finally, the components of the SC change over time for various reasons, from economic crises to natural events, or socio-environmental conflicts, which trigger specific CA. For example, in the context of environmental conflicts, internal SC could be expected to be higher than the external SC, since the conflict is in itself indicative of a breakdown of relationships (e.g., conflicts in Panguipulli and Puerto Piray).

We note a limitation in gathering information because it is difficult for the interviewees to remember the actions done in the past. Most could only remember recent actions and not necessarily the type of action or its frequency. Nevertheless, we did not explore whether there was a systematic response bias. The number of remembered actions may be influenced by

variables such as interviewees' age and their leadership status within the organization, or the type of organization (some have records of their activities, but others do not).

Despite these limitations, our results are revealing of the different possible combinations between SC and CA. These relationships are likely to change temporarily and spatially, for many reasons, in the same way that other forms of capital change.

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836   Supplementary Material.

837   1. Study cases selection

838   Table 1. Brief description of the selected study cases completed with data obtained from secondary sources and ground knowledge of the authors.

Study Cases	Location	General characteristics	Main threat to natural capital and ecosystem services
Panguipulli Municipality	Located in the Andes Range of Los Ríos region, southern Chile: 38°30' - 40°5'S and 71°35' - 72°35'W.	It covers an area of 3,292 km² of which less than 0.5% is classified as urban land. It comprises 20.7% of the region's total native forest area. Population reaches 32,617 inhabitants, of which the 30% belongs to the Mapuche indigenous groups (INE et al., 2005).	Forest degradation (the passage from old growth to degraded secondary forest or from secondary forest to shrubland)
Villa La Angostura Locality	Located to the south of Neuquen province, Argentina: 40°45'42" S - 71°38'46"W.	It covers an area of 79.6 km² surrounded by the Nahuel Huapi National Park. Tourism is the main economic activity. Related to native forests protection legal framework, there are 1593ha where no deforestation is allowed, 2079ha for sustainable use and 1991ha where deforestation and productive activities are allowed. Population reaches 11,063 inhabitants, all of them considered urban (INDEC, 2010).	Deforestation due to real estate development.
Balcarce Municipality	Located in the southeast of Buenos Aires province, Argentina: 37°50'47"S - 58°15'20"W.	It covers an area of 4,115.3 km² where approximately 70% of land is planted surface (33% with crops; 36 % with forage) while near 30% are natural or semi-natural grasslands, concentrated in lowlands and hills .Agriculture and livestock are the main productive activities. Population reaches 43,823 inhabitants, of which the 12.4% is rural (INDEC, 2010).	Loss of grazing lands and intensification in land use due to soybean expansion.
Puerto Piray Municipality	Located to the north of Misiones province, Argentina: 26°28'02"S - 54°43'05"W.	It covers an area of 354 km² and is located in the northern part of the Atlantic Forest of Alto Paraná. The forestry industry is important, having the largest and most modern sawmill in Argentina, belonging to a big forestry company. Population: 9,985 inhabitants, of which the 17.7% is rural; the 20.2% have unmet basic needs (INDEC, 2010).	Deforestation and intensification in land use due to agriculture and forestry, and land concentration in few owners.
Santiago del Estero	Located in the eastern portion of the Copo and Alberdi departments, in Santiago del Estero province, Argentina: 26°26′22" S - 62°11′01" W.	It covers an area of 13,507 km². The dry forests and grasslands was rapidly cleared since 1990s for the cultivation of soybeans and pastures. There is high socio-economic inequality, with native people developing subsistence activities in the shrinking remnant forests and large landowners expanding their productive activities. Population reaches 17,525 inhabitants, of which the 56% is rural (INDEC, 2010).	Forest clearing for soybean and pasture cultivation and land degradation due to overgrazing, and displacement of native people.

839   2. Constructing the social capital model

840   2.A. Methodology approach to social capital model

841   To see the reliability of the items to explain the dimensions of social capital (SC henceforth), we

842   analyzed in software e SPSS the Cronbach's alpha, which indicates the internal consistency of the

843   items within the same factor (dimension) (Batista-foguet et al., 2004; Verdugo et al., 2008) and which

844   is recommended to be greater than 0.8 (Milfont and Duckitt, 2004). It was also analyzed the item

845   correlation with the total of their scale, which is recommended to be greater than 0.30 to be taken

846   into account in the analysis (Blanco and Díaz, 2005).

847   The exploratory factor analysis (EFA) was used to investigate whether each dimension of SC were

848   correctly defined by the selected items (Batista-foguet et al., 2004). It is used the Kaiser-Meyer-Olkin

849   (KMO) test, which measure the sampling adequacy, which is considered a fair value when is over 0.7

850   (Milfont and Duckitt, 2004). We also analyzed the Bartlett's sphericity test, which analyze if the

851   correlation matrix is suitable for an EFA (Méndez Martínez and Rondón Sepúlveda, 2012). Thus, we

852   analyzed the EFA with oblique rotation (promax rotation with Kaiser normalization) to see how the

853   items were grouped in factors. We tested the extraction based on eigenvalue and also with a fixed

854   number of factors (we tested for 6, 7 and 8 components). It is considered that "strong data is data in

855   which item communalities are consistently high (in the order of 0.80 or above), factors exhibit high

856   loadings on a substantial number of items (at least three or four) and the number of factors is small"

857   (MacCallum et al., 1999). To retain items for subsequent analyses they need to have a factor loading

858   equal to or greater than 0.04. Items with double loadings which difference between them was less

859   than 0.1 were excluded (Milfont and Duckitt, 2004). The reliable factors for the model were renamed

860   as the different SC dimensions: internal cohesion, internal cooperation, external cohesion, external

861   cooperation, awareness and networks. An EFA was made for these dimensions, obtaining two

862   factors, named as internal SC and external SC.

863   The confirmatory factor analysis (CFA) provides indices of goodness of fit that would confirm the

864   adequacy of the factor solution (Milfont and Duckitt, 2004). We checked the items grouped by factor

865   (dimensions) obtained from the EFA by a CFA in software AMOS. We tested three different models:

866   In Model 1 we checked how the items (observables variables) contribute to the dimensions (latent

867   variables) and how all these dimensions contribute to SC. Model 2 was similar to the first one, but

868   we separated some items from internal cohesion dimension and named as internal participation and

869   we also differentiated internal SC (cooperation, cohesion and participation) and external SC (external

870   cohesion, external cooperation and networks). Model 3 was similar to the previous one, but we

871   removed one dimension (networks) and we did covariate both type of SC. We calculate the most

872 common fit statistics used in structural equation model (SEM) studies to assess the degree in which

873 the data fit the model (Blanco and Díaz, 2005; Milfont and Duckitt, 2004; Schumacker and Lomax,

874 2010), such as: the ratio of chi-square to degree of freedom ($\chi2/df$); the root mean square error of

875 approximation (RMSEA), the Normed Fit Index (NFI); Relative Fit Index (RFI); Incremental fit index

876 (IFI); Tucker Lewis index (TLI); comparative fit index (CFI) and the Akaike Information Criterion (AIC).

877 They were calculated for the three models, considering that lower values of the two first indicators

878 ($\chi2/df$ and RMSEA) and higher values for the next five (NFI, RFI, IFI, TLI and CFI) imply a better fit of

879 the model to the data (Blanco and Díaz, 2005) and that a model with lower value of AIC is preferred

880 (Milfont and Duckitt, 2004). Graphical output of the standardized estimates for the best fit Model

881 was made, calculating the coefficients of determination ($R2$) and the standardized regression weights

882 (B).

883   2. B. Results of the social capital model

884   As results from the exploratory factor analysis (EFA), the Cronbach's alpha based on all the items

885 was 0.827, which is a fair value (Table 1). When we discard from the analysis those items with the

886 correlation with the total of their scale less than 0.30, we have obtained a better Cronbach's alpha

887 value (0.831) which shows a high internal consistency.

888   Table 1. Cronbach's alpha of the structured and non-structured items related to the dimensions of

889 social capital (in red those items with corrected element-total correlation less than 0.3)

890

Cronbach's alpha	Cronbach's alpha based on the typified elements	N of elements
0.781	0.827	34

Type of question	Dimension	code	describe question / affirmation	Corrected element-total correlation
S t r u c t u r e d I t e m s	Reciprocity	RECIP_RA1	It is common for us to do favors within the group	0.294
		RECIP_RA2	When I do a favor to another member, I know it will be returned when I need it	0.35
		RECIP_ER1	Our organization provides a lot of collaboration to other organizations	0.396
		RECIP_ER2	Our organization receives a lot of collaboration from other organizations	0.191
	Trust	CONFI_RA1	The group works as I hope it works	0.35
		CONFI_RA2	I can talk honestly with the other members of the group	0.303
		CONFI_ER1	We work in a cordial way with other organizations / institutions	0.547
		CONFI_ER2	If the group has a problem, we turn to the judicial system because we believe it will solve it	0.104
		CONFI_ER3	We turn to the municipal government because we believe it will meet our demands	0.113
		CONFI_ER4	We have a high level of trust in the provincial government	0.205
		CONFI_ER5	We have a high level of trust in the national government	0.192
	Cooperation	COOP_RA1	We all work to achieve the goals and objectives of the group	0.485
		COOP_RA2	We usually divide the tasks within the group	0.36
		COOP_ER1	When we work with other organizations it is common to reach the goals we set ourselves	0.402
	Network Cohesion	COHES_RA1	We share the same values with the members of the group	0.471
		COHES_RA2	I share the norms of the organization	0.377
		COHES_RA3	It is common that we achieve consensus when making decisions within the group	0.205
		COHES_ER1	I feel that we share the same values with the members of the other organizations	0.364
		COHES_ER2	It is common that we achieve consensus when coordinating with other organizations	0.378
	Participation	PARTIC_RA1	When we make decisions it of the group is common for most of the members to participate	0.316
		PARTIC_RA2	When we do activities within the group, it is common that majority of members participate	0.483
		PARTIC_ER1	It is common for my organization to participate in joint activities with other organizations	0.485
	Awareness	CONSC_RA1	The [main threat to natural capital of each group] is the main problem of the rural area	0.296
		CONSC_RA2	The majority of the members of the organization is involved in the resolution of this problem	0.338
Non structured Items	Cooperation	COOP_RA1s	Motivation to cooperate with the group today	0.217
	Awareness	CONSC1s	Biophysical impact	0.081
		CONSC2s	Socio-economic impact	0.305
		CONSC3s	Total impact	0.287
	Network Cohesion	COHES_ER1s	Contribution of networks in group capacities	0.513
		COHES_ER2s	Group contribution to Network capabilities	0.41
		COHES_ER3s	As you consider these networks are	0.198
		COHES_ER1m	Quantity of relationship	0.139
		COHES_ER2m	Type of relationship	0.181
		COHES_ER3m	Motivation for cooperation	0.239

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892   With these items, the KMO test gives a result of 0.734 and the Bartlett's sphericity test gives an

893 Approximate Chi-square of 598.95, considered both fair results. Analyzing the EFA with oblique

894 rotation, the item communalities and the total variance explained improved when data was analyzed

895 with a fixed number of 8 factors than with the eigenvalue, which was of 5 factors. Therefore, we

896 continue working with the data obtained from the first one, even though in some cases the

897 recommendation about the number of items per factor was not met. The item communalities value

898 was 0.77 (being of 0.64 for the eigenvalue) and 77.4% of the total variance was explained with 8

899 factors (being 64.1% explained with 5 factors). Those items with factor loading less than 0.04 (e.g.

900 COOP_ER1) or those with double loadings with difference between them less than 0.1 (e.g.

901 CONFI_RA2) were excluded.

902   We have tested different models to see which one have a better fit, showing here three of them

903 which have contrasting results (Table 2): In Model 1 we checked how the items (observables

904 variables) contribute to the dimensions (latent variables) and how all these dimensions contribute to

905 SC; Model 2 was similar to the first one, but we separated some items from internal cohesion

906 dimension and named as internal participation and we also differentiated internal SC (cooperation,

907 cohesion and participation) and external SC (external cohesion, external cooperation and networks);

908 Model 3 was similar to the previous one, but we removed one dimension (networks) and we did

909 covariate both type of SC.

910 As results from the confirmatory factor analysis (CFA), the comparison of the three models

911 considered for the SC construct through different fit statistics have shown that Model 3 was the one

912 with best fit in all statistic (Table 3); for example: the RMSE evaluates if the questions respond to the

913 dimensions and the smaller it is, the better the model fits the data, being for this model 0.06; the CFI

914 represents the quality adjustment of the theoretical model presented and is considered an adequate

915 adjustment when is higher than 0.9, being for this model 0.96. Therefore, the model 3 was used to

916 measure the SC in the five study cases.

917 Table 2. Fit statistics obtained for the three models analyzed: ratio of chi-square to degree of

918 freedom (χ2/df), Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental fit index (IFI), Tucker

919 Lewis index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA) and

920 Akaike Information Criterion (AIC). Lower values for the indicators χ2/df and RMSEA and higher

921 values for the NFI, RFI, IFI, TLI and CFI imply a better fit of the model to the data and the model with

922 lower value of AIC is preferred.

Model	Model description	X2/DF	NFI	RFI	IFI	TLI	CFI	RMSEA	AIC
1	All reliable items and dimensions obtained from exploratory factor analysis (EFA)	2,03	0,66	0,52	0,79	0,68	0,78	0,11	272,8
2	Same as 1 but separating participation from cohesion and internal and external SC	1,61	0,79	0,67	0,91	0,84	0,90	0,09	184,7
3	Same as 2 but without Networks and with covariance of internal and external SC	1,26	0,86	0,75	0,97	0,94	0,96	0,06	125,9

925 3. Collective Actions

926 The methodology approach to analyze the items explaining the collective actions is similar as the

927 one shown for the SC in Supplementary material 2.

928 As results from the exploratory factor analysis (EFA), the Cronbach's alpha based on all the items

929 of collective actions was 0.886, which is considered a satisfactory value (Table 3).

930 Table 3. Cronbach's alpha of the items related to collective actions

| Cronbach's alpha	Cronbach's alpha based on the typified elements	N of elements
0.802	0.886	7

code	describe question / affirmation	Corrected element-total correlation
ACC_INFL	Influence of the Organization to improve the problem	0.308
ACC_HIZO	Have the organization carried out specific actions to solve the problem	0.863
ACC_CANT	Amount of collective actions carried out	0.704
ACC_VISIB	Public visibility of the collective actions carried out	0.707
ACC_IMPAC	Impact of actions in other organizations / institutions	0.764
ACC_CONQ	Conquest achieved through collective actions	0.676
ACC_CAMB	Changes in the problem based on actions taken	0.598

As all items had a correlation with the total of their scale greater than 0.30 they all were used to calculate the KMO test, obtaining a fair value (0. 869). Communalities were 0.70 or above, except for the item related to the influence of the organization to improve the environmental problem (0.16), which was not use on the rest of the analyses. Therefore, the items used to measure the collective actions for each study case were: if they have done or not, the quantity of actions, if they perceived that they have gained visibility and conquest with the action, the impacts in other organizations and if they considered that the problem have changed based on the actions taken. The 61.5% of the total variance was explained with 1 factor, therefore the factor loading of the components matrix were used as weighting factors for the items of collective actions.
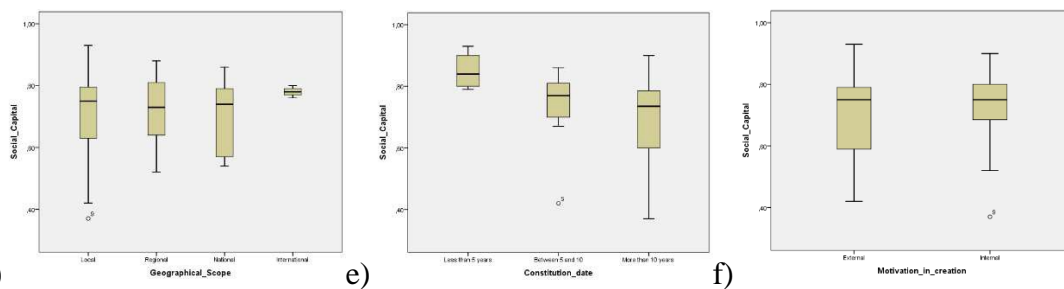
4. Relations among different organization characteristics and SC


a)   b)   c)

d)   e)   f)
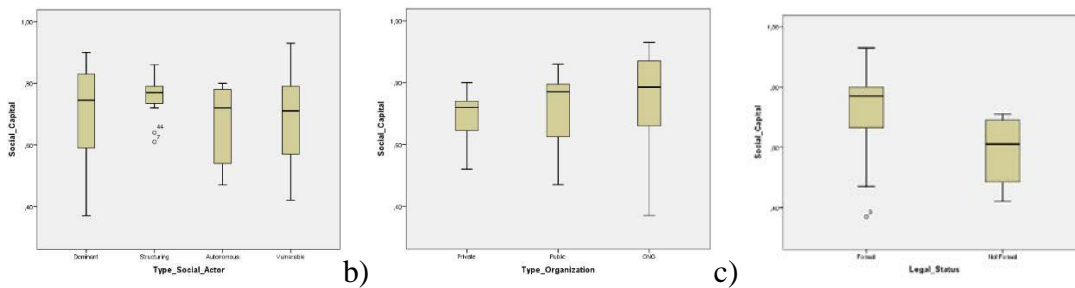
947   Figure 1. Boxplot graphs and results from the ANOVA test for comparing SC among
948   social actor (44 organizations) for all study sites defined according to different criteria: a) type
949   of social actor (Standard Deviation=0.132); b) type of organization (SD=0.132); c) legal
950   status (SD=0.131); d) geographical scope (SD=0.132); e) constitution date (SD=0.128); e)
951   motivation when the organization was created (SD=0.132).

952   **5. Relation between internal and external SC, and CA**

953   Figure 2. Scatter plot of the absolute value of the difference between internal CS and
954   external CS, and CA

$$y = -0.5493x + 0.5746$$
$$R^2 = 0.0799$$
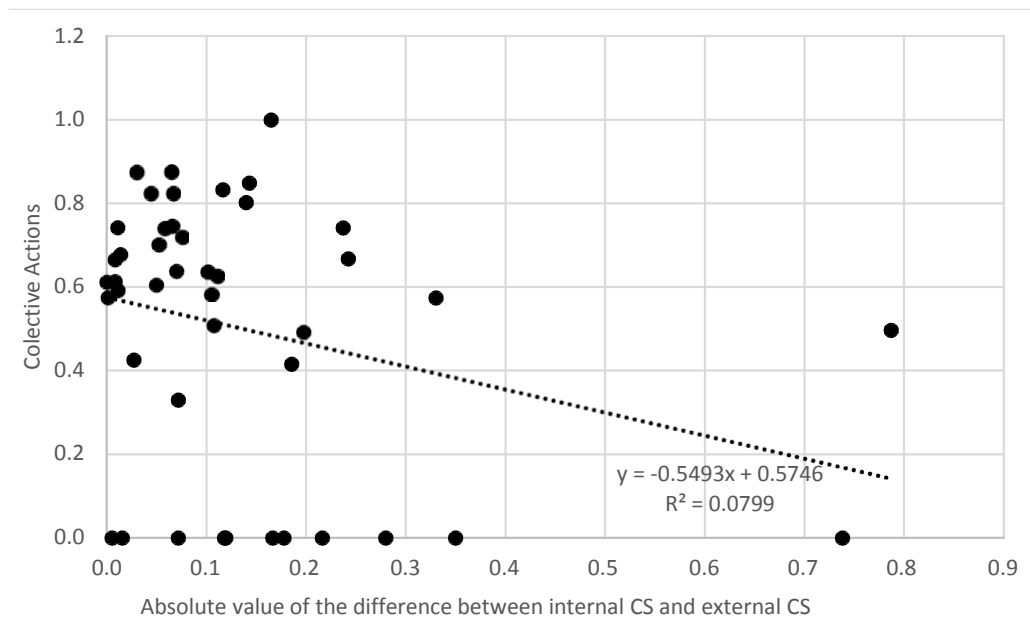
956   **6. Pearson correlation for SC, CA, awareness, involvement and amount of**
957   **relationships**

958   Table 4. Pearson correlation for SC, actions, awareness, involvement and amount of relationships

		SOCIAL CAPITAL	ACTIONS	AWARENESS	INVOLVEMENT	RELATIONSHIPS
SOCIAL CAPITAL	Pearson Correlation	1	,320	,130	,245	-,025
	Sig. (bilateral)		,034	,412	,118	,873
ACTIONS	Pearson Correlation		1	,598	,587	,454**
	Sig. (bilateral)			,000	,000	,002
AWARENESS	Pearson Correlation			1	,506	,319*
	Sig. (bilateral)				,001	,040
INVOLVEMENT	Pearson Correlation				1	,220
	Sig. (bilateral)					,161
NUMBER OF RELATIONSHIPS	Pearson Correlation					1
	Sig. (bilateral)					

959   * The correlation is significant at the 0.05 level (bilateral); ** The correlation is significant at the 0.01 level (bilateral)

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