

## "Social Capital for Watershed Management: Evaluation of Water Safety Agencies in Lower Balsas (Michoacán)"

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*Social capital, social learning, water security.*

### ABSTRACT

Abstract Water security (WS) requires the construction of social capital (SC) (Durstun, 2002). The objective of the present study was to analyze the CS building process at the community level in four microbasins of the dry tropics of Michoacán, Mexico, where social participation was promoted for the integration of bodies called: Local Water Safety Councils (COLSHID). The intervention model was based on adaptive management, which allows to consider the complexity of the systems (Brugge & Raak, 2007). The results were increment in each variable, and therefore in SC. It was observed that making explicit the participation of the process, increases interest and confidence.

### 1. INTRODUCTION.

Water security (WS) refers to the capacity of a locality, community, region or country to have sufficient quantity and quality of water for human use and productive activities, as well as to keep out water risks (either by lack or excess water)(Gray & Shadoff, 2007). The spread of SH is a basic objective for sustainable development. Therefore, intervention models to reach WS should be promoted in watersheds and marginalized territories, with the application of mechanisms of social participation from the local.

A key factor for the achievement of WS is the process of building social capital, understood as the set of social relations based on trust, cooperation and reciprocity, measured by

norms and values (Durstun, 2002). Social capital allows actors to mobilize resources to achieve common goals and distribute benefits.

Given the acute/severe and imminent crisis of water resources, the experiences of building social capital to reach the WS are an issue of interest and urgency. The record and analysis of local experiences, in specific water and institutional contexts, helps to identify the characteristics of social construction processes for different groups of actors. This generates learning for the design and improvement of territorial intervention models to replicate successful experiences in similar contexts. Due to this, the objective of the present work is to analyze the process of construction of social capital at local community level in a hydrographic system of small basins in the dry tropics of Michoacan, Mexico, where social participation was promoted for the integration of organs called Local Water Safety Councils (LWSC). This social intervention model was based on the adaptive management framework, which allows to consider the complexity of the systems, integrating different types of uncertainty in their program and making use of the system's self - organized properties (Brugge & Raak, 2007). Adaptive management of water resources emphasizes the importance of the management process, explicitly recognizing strategies to adapt them if necessary, rather than just looking at the final results (Pahl - Wostl, 2002). The process covers five points: problem definition, participatory planning, collaborative implementation, active follow - up, and integrative evaluation and adjustments (Pahl - Wostl et al., 2007).

## 2. METHODOLOGICAL FRAMEWORK

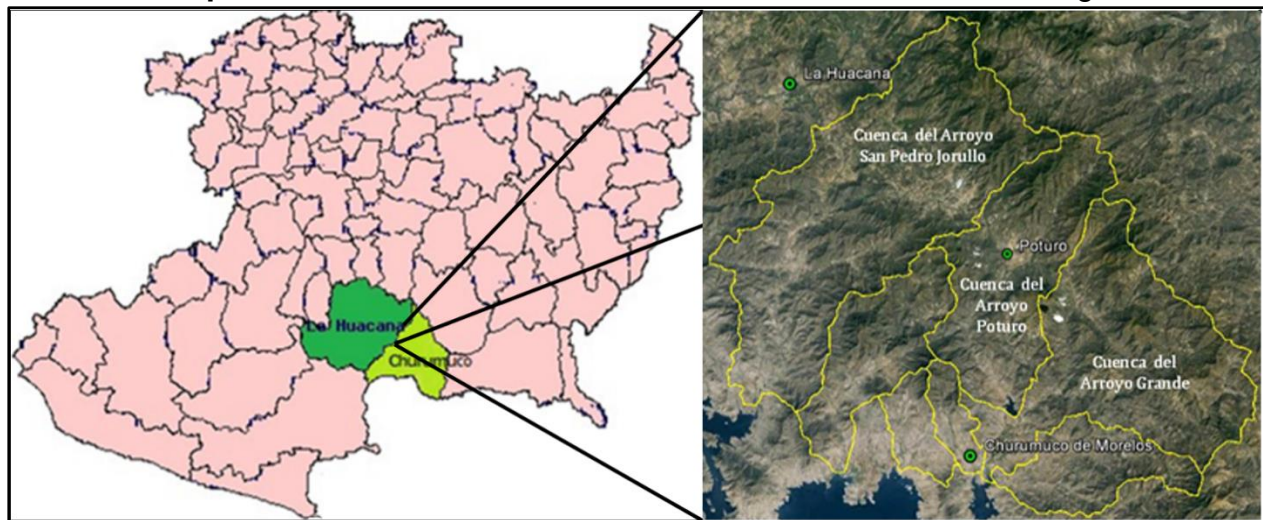
### 2.1. Area of study: Hydrographic system low Balsas

The case study was located in the lower section of the Balsas River Basin in the State of Michoacán (Fig. 1), which is representative of dry tropic conditions in Mexico. It is a rural area with high and very high index of marginalization (INEGI, 2015), with a high degree of vulnerability and that presents strong biophysical restrictions to support the rural ways of life. Due to the government's abandonment of the region for decades, the drug trafficking culture permeated the area, and since 2000 with the fracture between alliances between narcos and politicians, the area has become a photo of the expulsion of undocumented migrants to the States United States and the actions of organized crime groups (Maldonado, 2012).

**Map 1.** Location of the state of Michoacan, Mexico.



**Map 2.** Location of the four sub-basins to which the LWSC belong.



The area of operation of the LWSC is inserted in the hydrographic system of the Rivera Norte Presa Infiernillo - Bajo Balsas, with an approximate coverage of 1,090 km<sup>2</sup>, which comprises four sub-basins of elongated forms with extensions between 222 km<sup>2</sup> and 476.9 km<sup>2</sup>. The four sub-basins drain on the northern bank of the Infiernillo dam and share similar characteristics:

#### A) Water Context

The Bajo Balsas hydrographic system is located in an area with dry and hot climates, described as type Aw0 by Köpen classification (Trejo, 1999). There is a very marked seasonality, observed in two climatic periods:

## Rainy season

It occurs between June and September (CONAGUA, 2010), reaching up to 163 mm of rain in June (CONAGUA, 2015), causing flooding of rivers in the area and material losses due to flooding (i.e cars and crops), as well as obstruction of bridges, which causes communities isolation.

## Dry period

Temperatures range from 28 °C during the months March to October and 31 °C in April and May. And since the average monthly rainfall between February and May is 7.7 mm, there is a high level of evapotranspiration with an average of 260 mm during those months (CONAGUA, 2015). In addition to this, intermittent water currents predominate, followed by non-perennial currents; so that during this period about 50% of the water tributaries dry and the basin does not keeps water, there is a low water availability (Solórzano et al 2010).

The basin has a geology that has been shaped by volcanic activity, forming a pronounced relief with few plains (Férrandez et al. 1998), so that little sediment accumulates, causing rapid runoff and making it difficult to generate natural reservoirs of water (Davie, 2002).

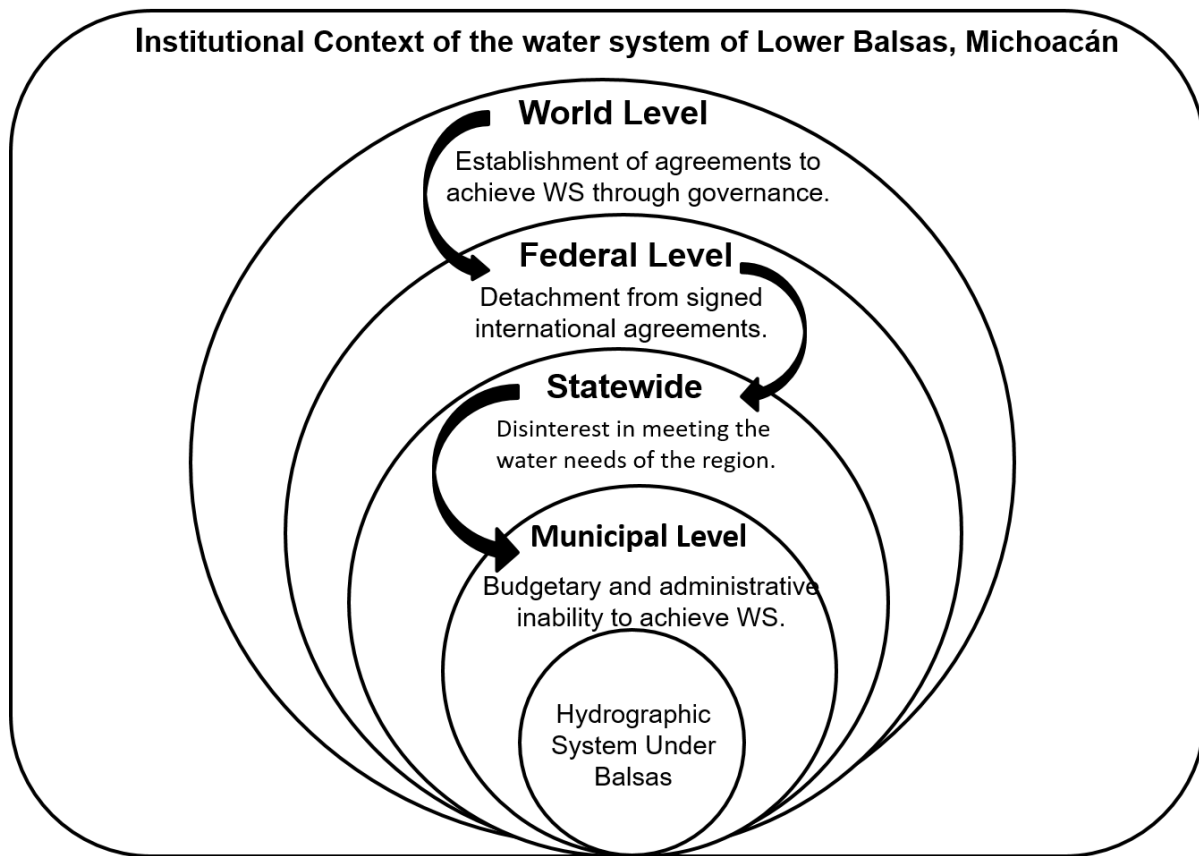
Regarding water quality, available water contains the highest levels of total coliform contamination during the year, reaching up to 500 CFU / 100 mm (Alvarado, 2015).

## B) Institutional context:

The water status of lower Balsas (Michoacan) shows a high vulnerability for the rural population, which requires institutional assistance to address this problem. However, despite the fact that Mexico has signed international agreements for the scope of WS, it does not have a strategy to detonate processes of citizen empowerment, inclusive governmental structures or to facilitate social participation for the construction of local solutions (Fig. 2). Public policies and units responsible of water resources management are hierarchical and dissociated from society (Pacheco & Basurto, 2008). This conclusion was evident throughout the process of construction and operation of the LWSC, the Federal, State and Municipal governments showed disinterest or operational incapacity to assist. In order to be a robust and durable institution for the management of commonly used resources, it is required:

1. Rules consistent with local needs and conditions.
2. The individuals involved must be able to participate in the modification of the rules.
3. There must be a system to monitor the behavior of members, specifically autonomously in the management of water resources (Ostrom, 1990).

**Fig. 1.** Institutional context in which the processes of social capital construction are inserted to obtain SH at a local community level in Michoacán, Mexico.



## 2.2. Intervention model and Social Capital indicators

In 2013, a small non-governmental organization (NGO) called Grupo Balsas A.C. and some academics from the Environmental Geography Research Center of UNAM (Morelia Campus), implemented a social participation strategy in the Bajo Balsas, for the construction of organisms to reach the WS, made up of local peasant institutions in Mexico, better known as ejidos.

These local bodies were called "Local Water Safety Councils" (LWSC) and constitute new organizational structures, constituting institutional innovations at the municipal level. In each basin an organ was installed, integrated in total by sixteen agricultural units (table 1). The organizational model was based on the application of the adaptive management framework with specific activities for each phase (table 2).

**Table 1.** Phases of adaptive management and participatory actions.

STAGE	Action
Definition of the problem	<ul style="list-style-type: none"> <li>Work since 2004 together with local communities to promote and achieve regional development and sustainable management of low deciduous forest.</li> </ul>
Installation and diagnosis	<ul style="list-style-type: none"> <li>Analysis of information on WS.</li> <li>Elaboration of water diagnosis.</li> </ul>
	<ul style="list-style-type: none"> <li>Reflection on decision making and decrease of uncertainty.</li> </ul>

Elaboration of the plan of works	<ul style="list-style-type: none"> <li>▪ Presentation of the plan of works by ejido.</li> <li>▪ Analysis and decision making to carry out joint actions for the construction of works.</li> <li>▪ Allocation of the budget.</li> <li>▪ Preparation of the work plan.</li> </ul>
Follow-up of the work plan	<ul style="list-style-type: none"> <li>▪ Reflection on contingency adjustment.</li> <li>▪ Analysis of ejido organization during the execution of the work plan.</li> <li>▪ Presentation of progress and difficulties in the work plan.</li> <li>▪ Accountability.</li> <li>▪ Joint construction on WS concept.</li> </ul>
Evaluation of the process	<ul style="list-style-type: none"> <li>▪ Detect areas of opportunity and strengths of the council.</li> <li>▪ Self-diagnosis of WS after the process.</li> <li>▪ Construction of vision for the future (independent of having financing or not).</li> </ul>

**Table 2.** Integration of each Local Water Safety Council.

<b>Name of the council</b>	<b># local actors</b>	<b>Identity the actors (ejidos to which they belong)</b>
La Laguna basin	2	<ul style="list-style-type: none"> <li>▪ Cumuato</li> <li>▪ Llano de Ojo de Agua</li> </ul>
Poturo basin	4	<ul style="list-style-type: none"> <li>▪ Poturo</li> <li>▪ Santa Rosa</li> <li>▪ Juntas de Poturo</li> <li>▪ Melchor Ocampo</li> </ul>
Arroyo San Pedro Jorullo basin	6	<ul style="list-style-type: none"> <li>▪ Los Copales</li> <li>▪ Cayaco</li> <li>▪ El Capitiro</li> <li>▪ David C. Manjares</li> <li>▪ Guadalupe Oropeo</li> <li>▪ Sinahua</li> </ul>
Arroyo Grande Churumuco basin	4	<ul style="list-style-type: none"> <li>▪ El Salitre</li> <li>▪ El Baral</li> <li>▪ El Platanar</li> <li>▪ Timbiriche</li> </ul>

The organization and operation of the four LWSC was gathered through the accompaniment of all its activities during the first year (2013) of operation, obtaining direct data. In order to examine the process of construction of the LWSC by lowering the grade of subjectivity in the analysis, a Social Capital Index (SCI) was constructed based on data obtained from direct sources. For their conceptual delimitation, parameters were identified, in turn conformed by attributes and indicators, and data sources were established for their feed (attendance lists, meeting minutes, databases, surveys and budget distribution reports), where:

$$ISC = CA + EP$$

CSI = Capital social index = 12

CA = Collective action = 6

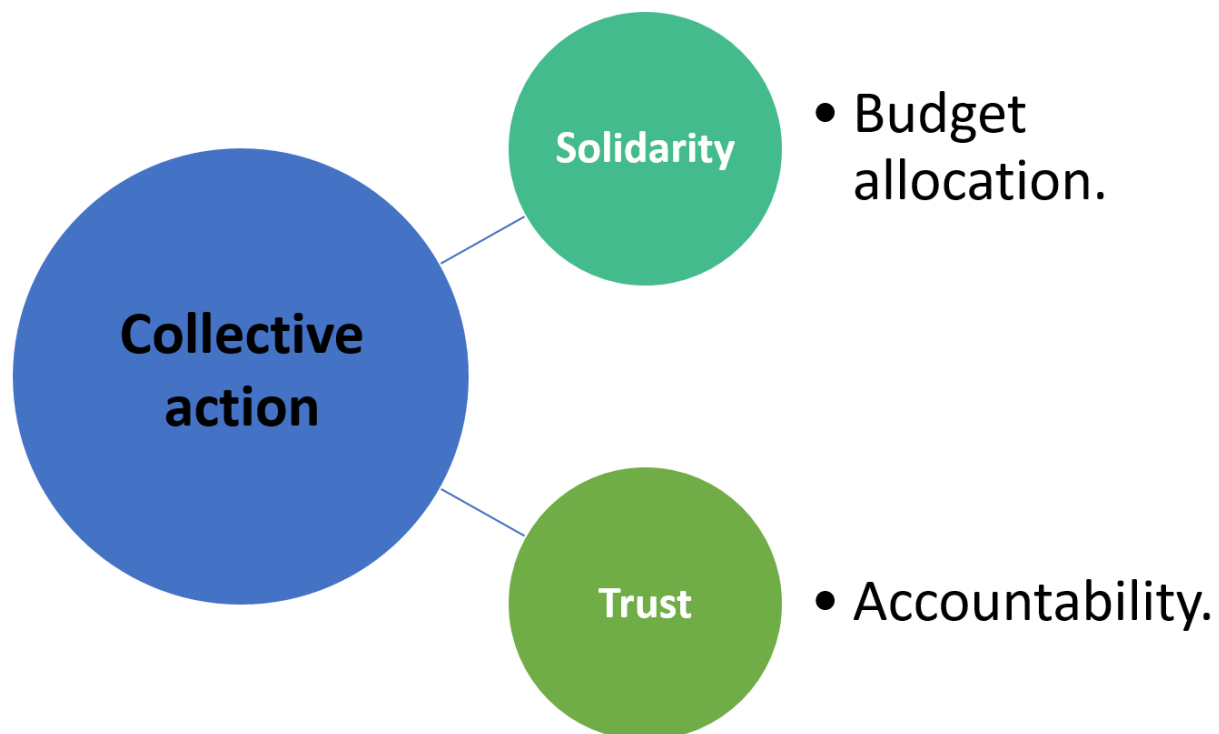
EP = Effective participation = 6

The CSI index is maintained based on the following fundamentals:

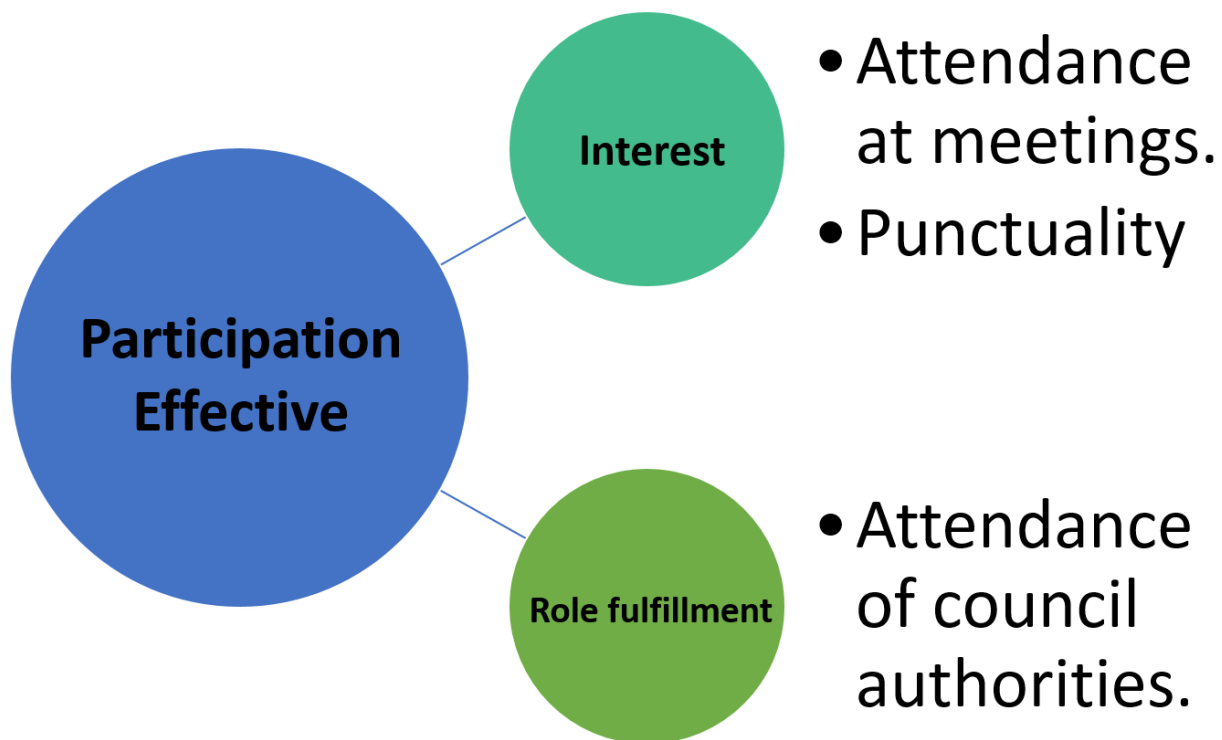
- Collective action is required to structure units at the local level to make decisions about the management of their natural resources (Reed, 2008).
- To achieve a process of building mature and lasting social capital over the years, there must be participation, solidarity and trust (Petty & Ward, 2011).
- In order for the management of water resources to be robust and comprehensive, it must include participation at different scales and different actors (ECLAC, 2003).

The social capital index is divided into the following two parameters:

**Fig.1.** The collective action parameter subdivided into attributes, with their respective indicators.



**Fig. 2.** The participation parameter subdivided into attributes with the respective indicators.



The conceptual support of the AC and PE parameters is presented below:

Collective action (CA): participatory integrated groups are needed in rural communities to obtain equitable and sustainable solutions to local development problems (Petty & Ward, 2011). The continued success of programs for long-term sustainability has been associated with the creation of local institutions (Cernea, 1987).

This parameter is shaped by three fundamental attributes for collective action within an institution to build social capital (Reed, 2008):

- Solidarity.
- Confidence.

Effective Participation (EP): The management of water resources requires the effective participation of users, to reach agreements and maintain long – term processes (Reed, 2008); Also for effective participation, requires group interest and the fulfillment of the roles of leaders; In turn, it gives institutional strength (Fiol, M. & Lyes, M., 1985). This parameter was divided in two fundamental attributes to carry out a process of effective participation of the councils (Reed, 2008):

- Interest
- Role fulfillment

The weighting AC (6) = Solidarity (3) + Confidence (3).



Weighting was established according to the incidence of factors in the AC: Solidarity is a factor that fosters confidence, and in turn, confidence increases solidarity expressed in repeated behaviors and reinforced expressions that communicate confidence, and in particular in Actions for the delivery of control over goods (ECLAC, 2007). Because control over economic goods has a major impact on trust (ECLAC, 2007), accountability was chosen as a source of analysis; And being that gives him in power of control over property is an important manifestation of solidarity was chosen the budget distribution as a manifestation of solidarity.

The weighting was assigned 60/40 since interest is a group attribute and therefore a larger number of members, and role fulfillment plays an important role, but refers to the behavior of a smaller sphere within the group.

$$P (6) = I (4) + CR (2)$$

**Table 3.** Conceptual support of the attributes of each parameter.

Collective Action	Effective Participation
<p><b>Solidarity (S):</b> Solidarity is a fundamental factor for the different members of an organ to benefit from the relationships they have built among their members (Reed, 2008), increasing the resilience of a group and reducing its vulnerability, which is necessary for the achievement of WS (Reed et. al, 2007).</p>	<p><b>Role fulfillment (RF):</b> It gives a sense of belonging on the part of the board members, as well as encouraging maturity in the process of building social capital (ECLAC, 2007). It facilitates communication between the parts by solidifying the organ (Reed, 2007).</p>
<p><b>Trust (T):</b> it is a fundamental value for the construction of social capital, since it contributes to strengthening the local institutions, facilitating that they last. Because accountability is an action related to honesty, the accountability of councils (ECLAC, 2003), will increase trust among council members.</p>	<p><b>Interest (I):</b> In order for local organizational structures to last through time, there must be interest on the part of its members to facilitate project negotiation and execution processes (Reed, 2007).</p>

Collective action:

The weighting of the attributes is established according to the criteria presented below:

**Table 4.** Data sheet of the Collective Action parameter.

<b>Parameter:</b> Community Action	<b>Acronym:</b> CA
<b>Formula to calculate the Index:</b> CA = S + T	

<b>Unit of measurement of the resulting value:</b> unit of scale			
<b>Parameter normalization scale in% to evaluate CA level:</b>			
Low level = 0	Medium level = 1	High level = 2	Highest level= 3
<b>Variable</b>	<b>Measure</b>		<b>Measure value</b>
S = Solidarity	Presence: the ejido vote for budget allocation according to the needs of each ejido (equitable distribution).		1
	Absence: the ejido vote for distribution in equal parts, regardless of the needs of each ejido		0
<b>Process</b>			
1. The number of ejidos was added per council that voted for equal distribution. 2. The percentage of ejidos that voted for equitable budget distribution was obtained: $\% = \# \text{ of ejidos that voted for equitable distribution} / \# \text{ of total ejidos in council} * 100$ 3. According to the% obtained the scale is classified based on table 5.			
<b>Variable</b>	<b>Measure</b>		<b>Measure value</b>
T = Trust	By percentage according to table 6.		1
			0
<b>Process</b>			
1. The% of money from which they were accountable was measured with the next formula: $\% = \text{Amount of money checked} / \text{Total money paid to council} * 100$ 2. According to the percentage obtained by council, it's the level of accountability was classified based on table 6.			

**Table 5.** Categorization of the level of solidarity among ejidos.

%	Level	Level description	Scale
0 - 25	Null	There is no solidarity between members of the organ.	0
26 - 50	Low	Under The ejidos privilege their individuality.	1
51 - 75	Moderate	Moderate Moderate level of solidarity.	2
76 - 100	High	High The ejidos are very supportive.	3

**Table 6.** Categorization according to the level of accountability.

%	Level	Level Categorization	Scale
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0% - 35%	Null	Almost no level of accountability, encouraging lack of confidence in the board.	0
36% - 69%	Low	Low level of accountability, affecting the credibility of council authorities.	1
70% - 89%	Moderate	Medium level of accountability, affecting the credibility of council authorities.	2
90% - 100%	High	High level of accountability, which encourages confidence and strengthens institutionality in the council.	3

**Table 7.** Data sheet of the Effective Participation parameter.

<b>Parameter:</b> Effective participation		<b>Acronym:</b> EP	
<b>Formula to calculate the Index:</b> EP (6) = I (4) + RF (2)			
<b>Unit of measurement of the resulting value:</b> unit of scale			
<b>Parameter normalization scale in% to evaluate CA level:</b>			
Low level = 0	Medium level = 1	High level = 2	Highest level= 3
<b>Variable</b>	<b>Measure</b>		<b>Measure value</b>
A = Asistencia	1) Presence: attendance per individual in a work session.		1
	2) Absence: absence by individual in a work session		0
<b>Process</b>			
The # of attendees was added to each session and the attendance% was obtained by following this formula: # of attendees to the session / # of the total summoned to the * 100 meeting. Subsequently, according to the percentage attendance at the meeting, it was classified in table 8.			
<b>Variable</b>	<b>Measure</b>		<b>Measure value</b>
P = Punctuality	1) Presence: Assistance by individual at the agreed time or 15 minutes maximum delay.		1
	2) Absence: Assistance by individual from the 16 minute after the agreed time. Process		0
<b>Process</b>			
The total number of one-on-one attendees was added to each meeting and the percentage was obtained according to this formula: # of specific assistants / # of attendees in total * 100.			

Variable	Measure	Measure value
FR = Fulfillment of roles	1) Presence: attendance of each authority in a work session.	1
	2) Absence: absence of each authority in a work session.	0
<b>Process</b>		
The number of attending authorities was added to each session and the attendance% was obtained with the following formula: # of attending authorities to the session / # of the total number of authorities convened at the * 100 meeting. Subsequently, according to the percentage attendance at the meeting, it was classified in table 13.		

### 3. Results

#### Collective action

Solidarity

**Table 9.** Results of percentage of ejidos that voted for equitable budget distribution.

Council	Ejidos that voted for equal distribution	% of votes for fair distribution	Scale	Category
La Laguna	2	100	3	3 The ejidos are very supportive.
Poturo	3	75	2	2 Level of solidarity.
A. Sn. Pedro J.	6	100	3	3 The ejidos are very supportive.
A. Gnde. Ch.	4	100	3	3 The ejidos are very supportive.

Average level of solidarity according to table 5 is scale 3: The ejidos are very supportive.

Trust

**Table 10.** Results of the percentage of accounts rendered by the ejidos.

Council			% cheked	Scale

	<b>Budget executed</b>	<b>Budget checked</b>		
La Laguna	\$42,300.00	\$41,790.00	98.8	3 Very high level of accountability.
Poturo	\$245,480.48	\$244,338.48	99.5	3 Very high level of accountability.
A.Sn. Pedro J.	\$417,995.00	\$402,855.00	96.4	3 Very high level of accountability.
A. Grande Ch.	\$256,799.00	\$256,409.00	99.8	3 Very high level of accountability.

Average confidence level according to table 6 is scale 3: Very high level of accountability.

The two attributes of the collective action parameter obtained the largest percentage in their scale:

$$AC (6) = S (3) + C (3) = 6$$

The level of collective action was 6 on a scale of 0 to 6.

Effective participation

Assistance

**Table 11.** Classification of LWSC assistance throughout the year.

<b>COLSHID</b>	<b>Classification</b>
La Laguna	Started with an average level of attendance, but from the second meeting remained at a high level of attendance.
Poturo	3 of the 4 meetings remained at an average level and only the second meeting had a high call.
Arroyo San Pedro.J.	The first session had a high level of call, the second medium level, the third high and the last two were maintained at a medium level.

Arroyo Grande Ch.	The first session had a high level of convocation, the second medium level, the next two returned to be high and the last level of convocation was average.
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The average attendance during the year was average, equivalent to 2 on its scale.

#### Punctuality

**Table 12.** Classification of the timeliness of LWSC throughout the year.

Council	Clasification
La Laguna	Punctuality was high during all meetings.
A. Poturo	Punctuality was high during all meetings.
A. Sn. Pedro J.	Punctuality was high during all meetings.
A. Gnde. Ch.	The level of punctuality was high during the first two meetings, however in sessions 3 and 4 decreased at low level, the last meeting returned to high level.

The average punctuality was high, obtaining 3 on the scale.

#### Role fulfillment

**Table 13.** Classification of council assistance throughout the year.

Council	Clasification
La Laguna	The average level of attendance was maintained during 3 meetings, but the fourth meeting was a low level, which requires a greater commitment from the authorities to strengthen the council as an institution.
Poturo	The first meeting was a high attendance and the rest of the sessions remained full attendance, reflecting that the council has consolidated as an important institution for ejidos with responsible representatives.

Arroyo San Pedro.J.	The first meeting attendance was average, the next three meetings increased to 100% and the last one had a high level of attendance. What expresses interest on the part of the authorities, nevertheless it is necessary that there is more evidence.
Arroyo Grande Ch.	The first three sessions had high attendance, however this decreased in the middle level in the third and low level in the fourth, indicating that we must work to strengthen COLSHID as an institution within the ejidos.

Role compliance (FR) was medium level, 2 on a scale of 0 to 4.

$$I (4) = A (1) + P (2) = 3$$

Interest is level 3 on a scale of 0 to 4.

$$\text{The EP} = I (3) + \text{FR} (2) = 5$$

The level of effective participation obtained was 5 on a scale 0 - 6.

Index of social capital

$$\text{ISC} = \text{CA} (6) + \text{EP} (5) = 11$$

The obtained level of social capital was 11 on a scale of 0 - 12.

#### 4. Conclusions

- The response level of the variables was very similar, which shows that they are closely related among them.
- An adaptive management framework that institutionalizes participation, making it explicit and part of the process, facilitates and encourages the construction of social capital, by increasing the interest and the trust.
- The process of building social capital was successful according to the variables analyzed in this paper and being that established in good level the principles of solidarity, trust and interest, it will be possible for the process to continue over time.
- Reducing the level of uncertainty to analyze a qualitative process, seeking to be as objective as possible, is complicated and requires careful study (observing different variables, both qualitative and quantitative), to achieve a complete picture of the process.

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