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Articles

Self-management in agricultural water management and distribution: Case of Pozo Zamorano, Hidalgo, Mexico

Autogestión en el manejo y distribución del agua de uso agrícola: caso Pozo Zamorano, Hidalgo, México

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Abstract

Several experiences of small irrigation units show that, based on social organizations, norms, uses and customs, and agreed arrangements for making decision have reached binding agreements on issues of collective interest, such as self-managed water systems, where through an organizational level, the activities of the irrigation system are carried out, such as water distribution, maintenance, conflict resolution, monitoring and surveillance. The study was aimed to know the self-management capacity of the "Pozo Zamorano" in water management, based on the design principles of long-term common use resources (CUR). The results show that the management of the resource is given by internal rules and regulations, economic sanction systems that have been established in a common way by the users, to allow good management and order within society. The design points proposed by Ostrom for organizations managed by the same users are present in the organization of the "Pozo Zamorano" society and it can be considered with a high performance. The self-managed condition of the irrigating partners has allowed them to give continuity to the agricultural activity, on which the majority of the community's inhabitants depend.

Keywords: Self-managing organization, agricultural irrigation, peasant irrigation, common-use resources, governance.

Resumen

Diversas experiencias de pequeñas unidades de riego muestran que a partir de organizaciones sociales, normas, usos y costumbres, y arreglos consensados para la toma de decisiones han logrado acuerdos vinculantes en torno a temas de interés colectivo, tales como sistemas autogestivos del agua, en donde mediante un nivel organizativo se llevan a cabo todas las actividades del sistema de riego, como distribución del agua, mantenimiento, resolución de conflictos, monitoreo y vigilancia. El objetivo del estudio fue conocer la capacidad autogestiva de la sociedad de usuarios "Pozo Zamorano" en el manejo del agua a partir de los principios de diseño característicos de los recursos de uso común (RUC) de larga duración. Los resultados muestran que la gestión del recurso está dada por normas y reglamentos internos, sistemas de sanciones económicas que han sido establecidas de forma común por los usuarios, para permitir un buen manejo y orden dentro de la sociedad. Los puntos de diseño propuestos por Ostrom para las organizaciones administradas por los mismos usuarios están presentes en la organización de la sociedad "Pozo Zamorano" y se pueden considerar con un desempeño alto. La condición autogestiva de los socios regantes les ha permitido dar continuidad a la actividad agrícola, de la cual depende la mayoría de los habitantes de la comunidad.

Palabras clave: organización autogestiva, riego agrícola, riego campesino, recursos de uso común, gobernanza.

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Introduction

In Mexico, irrigated agriculture is the most important water user, although urban and industrial uses surpass the agricultural sector in certain metropolitan zones, generating a struggle and conflicts over the scarce water resource, caused by population growth and development of the economy (Palacios-Vélez & Escobar-Villagrán, 2016); however, according to the National Water Law of 1992, the domestic use and the urban public use have preference in relation to any other use (DOF, 1992).

The irrigated agricultural surface in Mexico is 7.17 million hectares; 3.29 million hectares are managed by irrigation districts, and 3.88 million hectares are organized into irrigation units, which are integrated by users' associations or other forms of organization that operate, established to provide the irrigation service with autonomous management processes and to operate the water infrastructure works for capture, diversion, conduction, regulation and distribution of water for agricultural irrigation (Conagua, 2018).

Escobedo (1997) highlights that the small-scale irrigation systems are self-regulated and self-managed by the irrigators themselves, who have managed to form self-managing organizations with the capacity to

conserve the infrastructure and to manage the water; in contrast with large-scale irrigation, managed and controlled by state institutions.

Regarding the management of the water resource, it is suggested that it should be conducted in a decentralized and integrated manner, favoring direct action and decisions by local actors (DOF, 1992). From the social perspective of self-management, this implies management from the communities or from civil society, conceiving water as a constitutive element of life and for life in the community; this implies direct participation in decision-making, in addition to tasks of administration and execution of its resources for collective benefits, which can be material and immaterial, significant for the actors who manage them (Sandoval & Günther, 2015).

Regarding this, Ostrom (2000) highlights that various institutions which manage common use resources (CUR) have developed processes to become organized and govern themselves in order to obtain joint benefits, where the basis is the capacity of individuals to self-organize to solve problems without any type of external help. To show this, the author establishes seven design principles which characterize solid institutions, and an eighth principle for broader and more complex cases. Ostrom (2014) suggests that these design principles seem to synthesize the central factors that affect the probability of long-term survival of an institution developed by users of a resource.

The self-managing capacity of communities to manage agricultural use water has been documented in many studies. This study presents the case of the "Pozo Zamorano" Rural Production Society of Limited Responsibility (*Sociedad de Producción Rural de Responsabilidad*

Limitada, S.P.R. de R.L.), in the community of Zamorano, belonging to the municipality of Huichapan, Hidalgo, Mexico.

The objective of the study was to understand the self-managing capacity of the "Pozo Zamorano" users' society in water management, based on the design principles proposed by Ostrom (2000) which are characteristic of common and long-term use resources.

Governance, social organization, self-management

Self-management is independence of users for management, in constitutional aspects and collective decision-making, internal organization and administration, and mobilization of human and economic resources, as operating agents for water delivery, maintenance and infrastructure repair (Salazar, Saravia, & Rafael, 2010).

Water management can be defined as the set of agreements, rules and activities that make it possible for water to be distributed among different users and/or communities of irrigators, so that it can be distributed in an organized and adequate manner in agreement with the cultivation systems that they implement (Gerbrandy & Hoogendam, 2002).

Authors such as Alcántara-Santuario and Marín-Fuentes (2013) analyze the concept of governance from a general point of view, and they mention a meaning that is more linked to government, as synonym of governability with a framework of rules, institutions, and practices to direct the efficacy and efficiency in the development of their economic and social resources. However, it has gradually extended to the participation

in interdependent networks of government, private sector and civil society.

In this sense, Murillo-Licea and Soares-Morales (2013) indicate that both terms have appeared in the phenomena related to the integrated management of water resources and refer to governability when it is about the institutional part conferred to the government and its institutions, in their capacity and range of action; meanwhile, they consider governance to be the joint action of the government, plus the participation of society, based on the compliance and application of norms that regulate such an interaction. Likewise, the authors highlight that, for Mexico, concerning water governance, the presence and actions of social groups have increased with time. Thus, the pendulum of governability to governance shows a trend where social entities have increased in presence.

This is the case described by Morales-Juárez and Méndez-García (2021) for Huajuapan de León, regarding the tensions faced by what they call independent water systems (IWS), which are institutions established and managed by the users themselves that have consolidated and sustained local water management. In their analysis, through a Governance Analytical Framework (GAF), the authors establish three factors: payment of electricity for the extraction and maintenance of the supply system; coverage and expansion of the infrastructure due to the growing urbanization; and defense of water control with regards to the operating municipal agency.

The author call these "governance from below", since they are concrete actions driven by society, which originate within the community environment, with the intention of solving public needs and.

Murillo-Licea and Soares-Morales (2013) indicate that there are several legal instruments that deal with the issue of water in Mexico and they particularly highlight that its legal governance is found in the National Water Law (*Ley de Aguas Nacionales*, LAN, 2004), where the intention is to create an inclusive environment for civil society organizations to take actions in terms of water management; likewise, they indicate that social action passes through the limits of laws and underline the empowerment of social groups.

In this regard, it is important to emphasize various experiences of small-scale irrigation units, which, based on social organizations, norms, uses and customs, and consensus arrangements for decision-making, have managed to achieve binding agreements around themes of collective interest, such as self-managing water systems, where the units conduct all the activities of the irrigation system through an organizational level, such as water distribution, maintenance, conflict resolution, monitoring and supervision (Palerm & Martínez, 2000; Mazabel & Davison, 2007; Ocampo-Fletes, Parra-Inzunza, & Ruiz-Barbosa, 2018).

Here, it is worth mentioning that Palerm (2015) points out that once the water board delivers the water to the *ejidos* or the irrigation units, it no longer has an influence on the distribution that is done inside these organizations.

In this sense, the theories and analyses proposed by Ostrom stand out; the author shows, through the analysis of 150 irrigation systems in

Nepal, how a group of producers created rules to assign costs and benefits for building and operating their own irrigation system. Thus, she showed that one of the best strategies is cooperation, through the construction of robust institutions (Ostrom, 2014).

Ostrom (2014) suggests as analytical method, eight original principles for the design of lasting institutions, for management of common use resources, which promote governance from the local capacities and dynamics.

In this regard, Díaz-Rosillo and Mazabel-Domínguez (2011), through a series of scores and scales, evaluated the state of the presence of Ostrom's first seven principles, with the result being that the system presented a high level in the first four and in the seventh, it was low in the fifth, and medium in the sixth. They conclude that it is a self-managing group that can still improve, through the willingness of its members to occupy charges in the directive board, or to be in charge of the well, improving the communication for irrigation management and a greater definition of the sanctions from any failure to comply.

Similarly, Coral, Vicente and Romano (2017), when reviewing how common goods are collectively managed, which include sources of water, land, and forest, tourist and cultural resources in Agua Blanca, Ecuador, analyzed based on the design principles by Ostrom (2000) that characterize long-lasting institutions, find that the 8 principles are present, so they conclude that it is a model of social organization and sustainable management of natural resources.

Materials and methods

Characteristics of the community of El Zamorano

The study was carried out in the community of El Zamorano, belonging to the municipality of Huichapan, in the state of Hidalgo, Mexico. The municipality is located in western Hidalgo, between parallels 20° 22´ 24" latitude North and 99° 38´ 56" longitude West (Inafed, 2021). Figure 1 shows the irrigation system of the "Pozo Zamorano" society.

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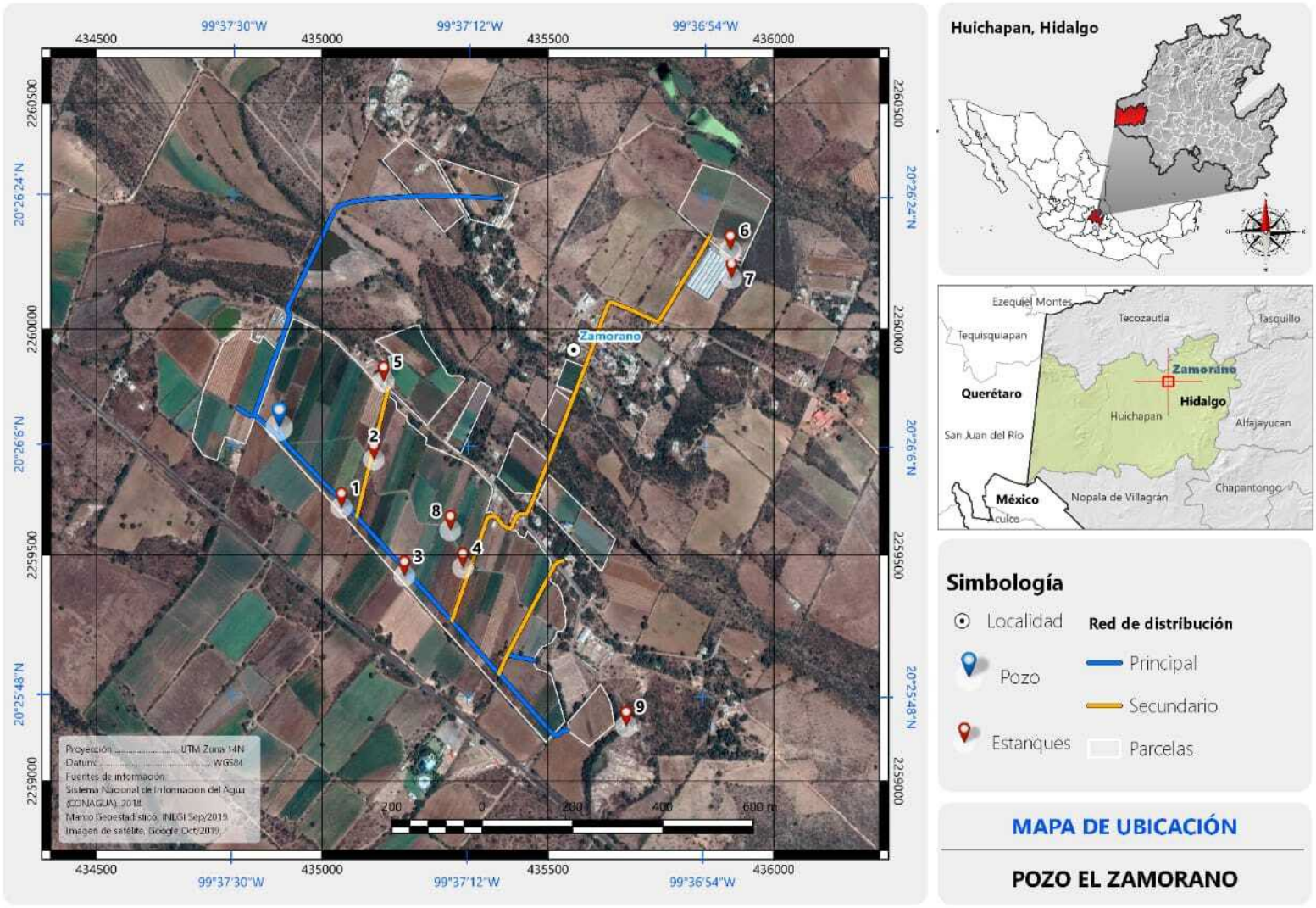

Figure 1. Localization of the community of "El Zamorano", Huichapan, Hidalgo, Mexico. Sources: based on the Geostatistical Framework by INEGI (2019), and Conagua (2018).

It borders to the north with the municipality of Tecozautla, south with the municipalities of Nopala and Chapantongo, west with the state of Querétaro, east with the municipality of Alfajayucan (Inafed, 2021). It

is located at 2,026 meters above sea level (amsl) (Pueblos América, 2021). It presents a temperate-cold climate, with annual mean temperature of 16 °C, mean annual rainfall of 437 millimeters per year with a rainy period in the months of May to September. The soils are from the Secondary, Tertiary, Quaternary and Mesozoic eras; it is a semi-desert and rich in organic matter and nutrients, the main use of the land is agricultural and pastureland, and in second place forestry use such as natural grasses, forest or rainforest. It is a soil of good quality with Phaeozem type predominating in 70 %, vertisol in 20 %, planosol 8 %, rendzina in a minimal part (Inafed, 2021). The last report indicates a population of 216 inhabitants (Pueblos América, 2021).

Study units

The study unit was the "Pozo Zamorano" S.P.R. de R.L, constituted by 27 water user partners who irrigate 27 hectares through the drip irrigation system and 3 by gravity.

Research techniques

To generate field information, the following research techniques were applied:

Survey. To record and measure different variables, to describe the social characteristics and to infer conclusions (Arnau, 1995), as well as to

know the opinion and the valuation of partners (Calduch, 2013); regarding functioning of the society, a census was conducted applying a questionnaire to the 27 members of the "Pozo Zamorano" society. The questionnaire included data of the producer and his family, agricultural surface, water management, participation in the organization for water management, and crops planted.

Interview. In a dialogue of interpersonal communication to obtain verbal responses and to gather data (Díaz-Bravo, Torruco-García, Martínez-Hernández, & Varela-Ruiz, 2013), a semi-structured interview was applied to the 27 water user partners. With this technique, the study delved into the aspects of water management and the functioning of the organization to distribute water. The information was recorded in written and audio-recorded form.

Participant observation. To capture details about facts and circumstances and to gather textual phrases that appear in the meetings, workshops or informal contacts (Alberich *et al*., 2009), the researchers became involved in the society's monthly meetings and in visits through the irrigated zone. In these activities, information was recorded about the infrastructure to store and distribute water from the well to the plots (principal and secondary piping) and the narratives of functioning, and the inconveniences that they presented during the distribution process.

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Design principles of long-lasting institutions

To analyze the capacity of self-management of the "Pozo Zamorano" society, the design principles characteristic of long-lasting institutions of common use resources suggested by Ostrom (2000) were applied. The author manifested that there are institutions for the management of common use resources (CUR) that have shown success coinciding with the presence of eight elemental principles, which have allowed the strengthening of these institutions. They are the following (Ostrom, 2000, p. 148):

> "1. Clearly defined limits: the individuals or families with rights to extract resource units from the CUR must be clearly defined, as well as the limits of the resource.
>
> 2. Coherence between the rules of appropriation and provision with local conditions: the appropriation rules that restrict time, place, technology and amount of resource units are related with local conditions and with the provision rules that demand work, material and money or both.
>
> 3. Collective action arrangements: mist of the individuals affected by the operative rules can participate in their modification.

4. Supervision: the supervisors that actively monitor conditions of the CUR and the behavior of users are responsible for them or else they are users.

5. Regulated sanctions: the users that violate the operative rules receive regulated sanctions (depending on the seriousness and the context of the infraction) by other users, corresponding public servants, or both.

6. Conflict resolution mechanisms: the users and their authorities have fast access to local instances to solve conflicts between the users, or between them and the public servants, at a low cost.

7. Minimal recognition of organization rights: the rights of the users to build their own institutions are not questioned by external government authorities."

Principle 8, nested entities, was not considered, which is applied when the system is part of broader systems.

Results and discussion

Characteristics of the "Pozo Zamorano" S. P. R. de R. L.

The society is integrated by 27 user partners with equal number of shares to irrigate 27 hectares. They are authorized to extract 144,180.00 annual

cubic meters, corresponding to 70 hours per partner by share per year. Water is for agricultural use; during the first years of use of the well water, it was used to sow corn and bean; it wasn't until 3 years later that vegetables began to be grown, with zucchini being the first crop introduced, followed by tomato, which was irrigated by gravity or flood, with lining canals; through the years, the irrigation system has been modernized and it is currently done by drip. Nowadays, the crops planted are alfalfa, corn, *ejotero* bean, zucchini, jalapeño chili pepper, tomato, cucumber and tomatillo. For the 2019 S-S cycle, a production volume of 802.526 tons was obtained and an extraction volume of 72,310 m^3 of water.

The destination of the production for the case of vegetables is directed at the market, commercialized mainly in Ixmiquilpan, Hidalgo, place where they are distributed to wholesale markets in Iztapalapa, Ecatepec, Tulancingo, Pachuca and a minority to Querétaro; likewise, in the case of fodders and basic grains, a part is for self-supply and another is destined to livestock.

The infrastructure is formed by the deep well of 180 meters of depth, 150 meters of piping, pumping equipment, electrification network and eight storage ponds, which are property of eight partners, so the use is personal. The well was drilled in 1998 and it is 1 kilometer away from the center of the community.

The partners of "Pozo Zamorano" recognize that water is one of the most important productive elements on which they depend; this is shown in the way in which they attempt to take advantage and care for the

resource, even avoiding their waste, maintaining an accurate record of the hours that correspond to each partner.

Institutional design principles from Ostrom (2000) present in the "Pozo Zamorano" S. P. R. de R. L.

1. Clearly defined limits

The "Pozo Zamorano" society is legally established and socially recognized with 27 "partner" users to exploit the water resource of common use extracted from the well to irrigate 27 hectares.

The licenced volume to exploit national waters from the subsoil is 144,180.00 annual cubic meters, which is why 70 hours correspond to each partner by share, in function of the surface they own (Table 1).

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Table 1. Water distribution in function of the surface owned by partners of "Pozo Zamorano".

Producer code	Shares	Hours of water	Surface (ha)
1-ACM	0.5	35	0.5
2-ACM	1	70	1
3-AMM	2	140	2
4-AMC	1	70	1
5-AMR	1	70	1
6-ACM	1	70	1
7-AMM	0.5	35	0.5
8-BMM	1	70	1
9-CMM	1	70	1
10-DC	1	70	1
11-EMM	1	70	1
12-ECM	1	70	1
13-EMM	0.5	35	0.5
14-FCT	1	70	1
15-FMV	1	70	1
16-GCC	1	70	1
17-GMM	1.5	105	1.5
18-HEEM	1	70	1
19-HMM	1	70	1
20-J.AMM	1	70	1
21-JMMM	0.5	35	0.5
22-LCR	1	70	1
23-MCM	1	70	1
24-MCC	1	70	1
25-MMM	1	70	1
26-MMM	1	70	1
27-SMM	1	70	1

Source: Sociedad "Pozo Zamorano" (2005).

Every share is equivalent to a hectare and distributed from 0.5 to 2.0, with the mode being one share (21 irrigators), 4 with 0.5 shares, one partner with 1.5 and another with 2 shares.

It is important to highlight that the shares that correspond to each of the partners of the society are defined, which allows maintaining control and avoiding for other users to make excessive use of the vital liquid, the volume allotted to each is respected and only the "partners" are recognized as people instituted in the "Pozo Zamorano" society as those authorized to make use of the water, distributing it in the indicated surface; likewise, no outside person can appropriate the common use resource.

Ostrom (1990) considers that if access to a resource of common use is free and there is a large demand of what is extracted from it, the discount rate will approach 100 % for all the participants, so that overexploiting the resource will be an almost unanimous strategy. Therefore, the author indicates that:

> "Defining the borders of the resources of common use and specifying clearly who can use them is a necessary condition to attain their sustainable management" (p. 91).

The same author identifies that the problems that CUR users face are of two general classes: appropriation and provision or supply. The first

are related to the limits of resource allotment, since an adequate allotment implies the reduction of uncertainty and conflict.

In the case of "Pozo Zamorano", stemming from Table 1 on the distribution of water in function of the surface, it is possible to see that the users who are allowed to make use of the water resource for its exploitation are well-defined, offering the same panorama than in the cases of Díaz-Rosillo and Mazabel-Domínguez (2011), for the irrigation system in *ejido* San Juan, Guanajuato, Mexico, where only the partners have rights, since the amount of hectares defined are the suitable ones which can be supplied by the well.

The same situation was seen in the analysis carried out by Coral *et al*. (2017) in the community of Agua Blanca in Ecuador, where the users of each of the three sources of water supply analyzed are clearly defined.

2. Coherence between the rules of appropriation and provision and the local conditions

The regulations consider measures for use, which is why it declares that (Reglamento Sociedad-PZ, 2019):

All the users of the "Pozo Zamorano" society can use the resource that correspond to the year, according to the amount of water allotted per share, as long as they comply with the following rules:

1. To be able to use the water, the users should be up to date in terms of the fees established by the society, should not have any sanctions, and should comply with the "faena" activities agreed upon.

2. Only the "principal partners" can make use of the resource, although in the case of outside people who are renting plots, thay can be subject to accreditation from the general assembly, and if accepted they can use the resource although the principal partner is the one responsible of attending general assemblies, making decisions, being up to date in fees, tasks and activities established in meetings.

3. For a partner to be allotted water, he should sign up with sufficient time ahead, on the shift board that is located in the well, placing with legible handwriting his name, the date requested, the hours required, and if the case may be, the name of the irrigation group.

4. Every user will be responsible for closing the necessary valves for other users to be able to use the main lines when the requested time is over, which is known as "delivering water", otherwise the resource will not reach the next shift.

5. When water pumping from the well begins, and it is led through the main line, all the users that did not request the shift will have to have their valves or crossings closed, and in the case that a person who did not request it has an opened crossing, this will be considered "theft" and one of the following options could take place: become recipient of a fine, allot the amount of time used to the water shift of the user caught; however, there can be other internal arrangements, such as being forgiven by the person affected, although in the case of re-offending the case will be presented in the general assembly so that the applicable is determined.

6. In the case that there are no people signed up in the water allotment shift board and a user wanted to use it for just one hour, it could not

be done, since the minimum amount that can be requested will be 3 hours and this is called "arrancón" which is the minimum time to turn on the pump.

7. For the users who decide to irrigate by gravity, and which do not have tools of their own (such as the starting coupler), they will be able to use the ones that belong to the society; however, they will have to return them as soon as they stop using them, which is why it is strictly prohibited to take them home, and in the case of , will receive a fine and water will not be supplied the next time they request it.

8. In the case of a user who is transplanting his crop, a limit of water use of only 6 hours is established, and later the opportunity will be given to another user, only if they are signed up in the shift board, or else the well pump will be turned off.

9. In the general assemblies conducted every first Sunday of the month, the report of water use for each user to date will be provided, to have control of the remaining hours, and it will also be possible to corroborate that the users are up to date in payment of electricity, so that in the case of debtors they will not get a shift and will be exhibited in the general assembly.

10. In the general assemblies, the partners who are renting a plot with water rights or who are purchasing hours will also be made known, with the aim of keeping a record of hours of water use of the users implicated.

11. When a partner wants to take water to another plot of their property different from the one programmed, they will have to inform the

general assembly beforehand, to keep a record of the change and depending on the case, to include it with the most convenient irrigation group.

Concerning the coherence between the appropriation and restoration rules (Ostrom, 2000), the existence of a proportionality between the contribution carried out by each participant for the system's maintenance and the resource units that are appropriated is believed to be very important. Mancur (1969) indicates that there must be "fiscal equivalence" if such an equivalence does not exist; those who contribute in excess will have the sensation of cheating and will tend to show a lower level of commitment with compliance of the rules, which can give rise to a sequence of defaults.

Supporting this, Apollin and Eberhart (1998) state that an irrigation system can be understood not only as a work of infrastructure, but rather obeys a multiplicity of social components that underlie it; they indicate that:

> "Before being a work of civil engineering, an irrigation system is a social construction that leads human groups, communities and individual men and women, to collectively define the modalities of access to water and of creation or conservation of water rights, as well as the obligations and rules that they all have to fulfill to maintain and conserve access to this resource. These norms are derived from social agreements and power relationships between populations. Within these power relationships those that

> result from the differences in access to land, ethnic condition, gender condition of men and women, economic and social differentiation, and agroecological conditions are very important" (p. 9).

Ostrom (2000) indicates that the problems that users face are solved through the norms, regulations and institutions that are important mechanisms for CUR sustainability. In this sense, the author argues that the local users and not an external agent are the ones that have the best information to design the rules of appropriation and provision.

An example of this is the case that Durand (2011) reports, for the peasant community of Cullpe, Peru, where when the new infrastructure for drip irrigation (formerly flood) was introduced, the set of beneficiaries had the task of defining the distribution form of the well water, creating irrigation groups. At the same time, the work implied both the definition of norms and sanctions for the users, as well as the organization of the users' group for maintenance tasks; a similar situation is reported by Coral *et al*. (2017), when they refer to the Community of Agua Blanca (Ecuador), who indicate that the users pay five dollars monthly and are in charge of maintaining the facilities.

For this study, as well as for the case by Montiel (2020) in the municipality of Texcoco, describe how local institutions, hydraulic infrastructure, normativity, as well as the social organization for irrigation, facilitate understanding the functioning and the importance of community management of the water.

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3. Collective action arrangements

> "Most of the individuals affected by the operative rules can participate in their modification", Ostrom (2000).

There are the following agreements within the society, which are created through dissertation and consensus of all the associates:

1. In the year 2015, there was an agreement to hire a person designated to switch on and off the pump of the "pocero" well, and as the one responsible for keeping track in logbooks every two months for each user (name, concept of total hours consumed, amount to be paid, months), and at the end of the first and second semester, the reports about the well's consumption of electrical energy (hours worked), amount to be paid and income from payment from the users (payment for hours worked in the well); before, each user was entrusted to represent for 15 days and to perform those tasks, situation that soon caused nonconformity among the partners.
2. The creation of irrigation groups and shift allotment was implemented since the year 2015, and previously a shift was requested from the president, creating conflict because the ones chosen "as priority" were his family members or friends, and in fact two or more users could coincide at the time of asking for a shift and this caused discomfort among irrigators.

This modification came together with the implementation of a board to note down irrigation shifts (date, hour, irrigation group/individual

depending on the case), and with easy access for all, and this became the only way of requesting the service.

3. The creation of a cleaning committee for canals and main lines (valves, filters, leak repairs), "Committee for cleaning and maintenance", was agreed upon since the year 2018, and before, the society's president was the one in charge of designating the users responsible for performing such an activity.

This way, it was possible to overcome the differences with these norms established in agreement by all the partners.

The aforementioned are collective election arrangements, as indicated by Castillo (2004):

> "They are agreements created in a participative and inclusive way, and they were given as a space to attend to the demands and where all of the partners could have an impact".

This is how the criterion of "institutional strength" is fulfilled, which Ostrom (2000) takes on from Shepsle, where operative rules have been created and modified throughout time in agreement with a set of rules of collective and constitutional election.

Just like the case of Pérez-Magaña, Macías-López and Gutierrez-Villalpando (2019), for small-scale irrigation systems in Puebla, Mexico, the producers carry out collective actions such as the emergence of

customary rules to address the problems that happen with infrastructure and organizational problems.

4. Supervision

The ones responsible of supervising the good management of water (CUR) is the acting committee. There is not a specific position for a person to be in charge of supervision so that the batch shifts (irrigation groups) are fulfilled and the time requested is respected; therefore, all the partners monitor the good performance of the system and respect the time requested.

The following actions are implemented by the committee: at least twice a year the partners are designated, in groups of eight people, to give maintenance to the irrigation infrastructrure, which includes the main and secondary lines, valves, among others, in order to avoid leaks and greater problems.

To keep the canal clean and avoid obstructions for good water distribution, in the assembly there are agreements regarding the date for supervision of the canal infrastructure, which is monitored by the "Committee of cleaning and maintenance". Each irrigator should comply with cleaning of his stretch, otherwise he immediately receives a sanction.

Before, there was a shift with turns every two weeks, assigning to each partner the task of switching the pump on and off every day. However, this agreement did not work, since each partner was busy in his activities and considered that tending to the pump was wasting his day,

so the "Pozo Zamorano" society suggested hiring another person who is not a partner, who began to work since 10 years ago.

The person is from the community and trustworthy, the society gives her housing in the facilities of the well, she's exempt from paying utilities, and receives a salary that users pay. Likewise, she is the one in charge of switching on and off the well's pump, and of keeping track of the hours of use of each partner.

Ostrom (2000) argues that supervision is key in the success of management of these CUR, since it leads to credible commitments. It is not any sort of supervision, but rather one with incentive systems for individuals who detect violations. Thus, the supervision results both in private benefits for the supervisor and in joint benefits for others when continuity of the commitment is reinforced, and because it is a good incentive to avoid the free rider problem.

The same author uses theoretical reasoning to reach the conclusion that, in fact, the supervision costs will tend to be lower if monitoring is performed by users of the system themselves, rather than by an external authority, as long as the rules have also been designed by the users.

Just as the case presented by López and Palerm (2001), for water boxes in the valley of Coeneo-Huaniqueo, Michoacán, Michoacan, other than the vigilance council, there are no more people designated to perform this ever-present task; however, this activity is carried out by all those involved in the system.

What was reported by Mazabel and Caldera (2019) is repeated for the users, since the same as in the study of the "Pozo Zamorano" organization, they are the ones in charge of watching over the irrigations

for them to be performed effectively and they are attentive to the use that could be excessive or which could result in wasting the resource. The activities of supervision and monitoring constitute the activities of the system, which contribute to its functioning and operativity.

5. Regulated sanctions

The regulated sanctions range according to the seriousness of the problem, and the following were found (Reglamento Acta-PZ, 2019):

1. Any person who is caught stealing machinery, tools, products, inputs, firewood or others, will receive an economic sanction of $5,000.00 which he should provide to the committee in a general assembly, where he will be exposed publically in order for everyone to be aware of the situation.
2. When a person does not attend the tasks or collective works agreed upon (maintenance of main lines, canals, roads), he will get a fine of $200.00.
3. Non-attendance to general assemblies are sanctioned with payment of $100.00.
4. Losing the starting coupler of the society implies an economic sanction of $500.00 and, if it is damaged, the partner should pay for the repair and will be prohibited from asking for it again.
5. Any member who is caught stealing water, in addition to covering the hours of pumping for the partner affected, should cover an

economic fee if the crop or terrain is damaged, which will be at the discretion of the person affected.

6. If the irrigation head (crossing) or the main line presents any leak or failure, in the lands of any of the partners, which has been caused by mechanical damage or damage from animals, the partner will receive a fine, if he does not make the repairs in the time agreed upon in the general assembly, which fluctuate between $100.00 and $500.00.

Oliver (1980) suggests that, if a member who usually complies with the norms is punished harshly as consequence of a sporadic infraction, it is very likely that he will be resentful and in the future will feel less committed to respecting the norms. Ostrom (2000) starts from this reasoning when considering the issue of sanctions.

Ostrom argues that, given that there is an abundance of opportunities for users of a common use resource to adopt opportunistic behaviors, even the most loyal compliers of the norms can fall sometime into the temptation of violating them. Since it is the users themselves who supervise and impose sanctions, they have complete information about how the rest of the participants have behaved in the past. If someone violates the norms occassionally, a very small punishment will be enough to remind them of the importance of not repeating the offense, because the entire community knows what has happened and the offender knows that if the situation repeats he will lose his reputation. However, repeat offenders will receive harsher punishments, so that they do not become habitual transgressors and so that this behavior does not become generalized, as consequence of the strategy of conditional adhesion to the fulfillment of regulations adopted by the entirety of participants.

Such is the case presented by Hernández-Rodríguez and Moreno-Vázquez (2018) in the irrigation unit of Los Ángeles, Sonora, Mexico, where users have taken advantage to avoid complying with the rules, due to the absence of sanctions, and now seek to solve the diversity of problems that they face.

López and Palerm (2001), and Díaz-Rosillo and Mazabel-Domínguez (2011) indicate that the sanctions given to users in the irrigation system are, among others, due to non-assistance to tasks.

6. Mechanisms for conflict resolution

For conflict resolution, the society has different mechanisms to reach agreements. When an irrigator forgets to close his valves, what is known as "delivering water" and steals it in another partner's shift, they resort to dialogue to reach an agreement, at the discretion of the person affected, which can be to note down 15 to 30 minutes of time of use to the partner accused. If an agreement is not reached, the issue is analyzed in the general assembly and determined there; if the action is frequent, the partner becomes recipient of an economic sanction.

When the circumstances are foreign to them, the partners resort to the corresponding government agencies, depending on the case, for failure in electricity (CFE) and issues related to water (Conagua).

Although the dialogue is an efficient and very common tool to solve conflicts in the irrigators society, it is necessary to listen to both parts since blocks in agreement processes many times have more to do with

emotions, as indicated by Viñuales and Celaya (2005) for Spain. Without "managing" them, it is not possible to establish solid bases in the dialogue process.

For their part, Mazabel and Caldera (2019) state that for the community of La Virgen, Guanajuato, Mexico, there is also good communication and interaction between users regarding any issue related to irrigation and in the case of any disfunctionality or problem, they immediately communicate it to the *pozero*. Likewise, some of the problems generated over time are settled or resolved in assemblies or before the well committee.

The same was reported by Díaz-Rosillo and Mazabel-Domínguez (2011), in the *ejido* San Juan Urireo, Guanajuato, Mexico, where they resort to the person in charge when there are problems, in order for him to call for a meeting, and a solution is sought jointly; and, if necessary, for him to ask the corresponding agencies for support.

7. Minimum recognition of rights of an organization

The members of "Pozo Zamorano" have created their own rules, since they obtained the concession and signed up as S.P.R. de R.L. in the year 2006. This is in writing, specified in a certificate under seal before a public notary, that the society establishes its own rules; the organization and regulations are recognized by Conagua, the Technical Committee of Underground Water from the aquifer Huichapan-Tecozautla-Nopala (Comité Técnico de Aguas Subterráneas, COTAS).

These regulations are found in the acts book of the society and have the authorization signature of each partner.

For users of a common use resource to have the right to be recognized implies three things for Ostrom (2000). In the first place, that they are the ones who, at least in part, design the norms. In the second place, that they all know that if someone does not agree with those norms, it will not be simple to go to an external authority for them to be revoked. In the third place, that they have external support to make their property rights on the resource valid in the presence of third parties.

The recognition of users' rights who approprite resources are not questioned by external institutions, and as the case prsented by Giménez and Palerm (2007), for Spanish irrigators organizations, it can be stated that the institutional continuity and strength of irrigator organizations is closely linked to their own organizational capacity, but also to the recognition by the State, which reinforces and contributes to the self-managed organization. Therefore, the lack of it and its bureaucratization provokes the institutional weakness of irrigators' organizations.

The organization of irrigators assumed self-management the same as in most of the cases studied by Salazar *et al*. (2010), taking under their exclusive responsibility the functioning of the irrigation systems, giving the system a higher degree of sustainability due to the strengthening of their organization.

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Conclusions

The "Pozo Zamorano" users have well-established limits for the resource, which allows avoiding a greater exploitation than the volume allowed and restricting the exploitation only to partners.

For the irrigation users of "Pozo Zamorano", their organizational and self-management capacities have resulted in real advantages in water distribution, in participation and in decision-making.

The design points proposed by Ostrom for the organizations managed by the users themselves are present in the organization of the "Pozo Zamorano" society and can be considered of high performance.

The self-managing organization of irrigators from Pozo Zamorano has allowed to give continuity to the agricultural activity.

The self-management of the resource is given by internal norms and regulations, systems of economic sanctions that have been established by common agreement by the users, to allow good management and order within the society.

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