

Water Resources Management in Rural Communities of Northern Puebla

Juárez-Lucas, Plácido¹; Bustamante-González, Ángel^{2*}

¹ Colegio de Postgraduados campus Puebla. Centro Regional de Formación Docente e Investigación Educativa (CREDOMEX), Estancia posdoctoral CONAHCYT – Col. Barrio de San Antonio, Axapusco, Estado de México. aquilesleon807@gmail.com.

² Colegio de Posgraduados Campus Puebla. Santiago Momoxpan, Cholula, Puebla.

* Correspondence: angelb@colpos.mx

ABSTRACT

Objective: To identify the organizational forms that communities use to manage water, establishing the dialogical factors that communities build to strengthen their water-based ties.

Methodology: The study was conducted in eight communities of the Sierra Norte of Puebla. An action research approach was used to study community water management in eight auxiliary boards of the municipality of Ixtacamaxtitlán, state of Puebla.

Results: Seven water sources were identified, including one intercommunity source. The 8 auxiliary boards are built around these sources and they are organized to manage the home and irrigation water supply as a community. Differences in organization were identified depending on the land ownership type of the water source location, water fees, number of users, and years of management of the source.

Study Limitations/Implications: The mining conflicts in the study region limited field work.

Conclusions: Users have more access to water sources in ejidos than in small private properties. In the first case, water is considered a collective resource, while in the second case, water is a private resource.

Keywords: water, community, Sierra Norte.

Citation: Juárez-Lucas, P., & Bustamante-González, Á. (2024). Water Resources Management in Rural Communities of Northern Puebla. *Agro Productividad*. <https://doi.org/10.32854/agrop.v17i12.3175>

Academic Editor: Jorge Cadena Iñiguez

Associate Editor: Dra. Lucero del Mar Ruiz Posadas

Guest Editor: Daniel Alejandro Cadena Zamudio

Received: June 25, 2024.

Accepted: November 13, 2024.

Published on-line: December XX, 2024.

Agro Productividad, 17(12). December. 2024. pp: 15-23.

This work is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International license.



INTRODUCTION

Water availability and management in Mexican rural communities have characteristics that set them apart from the urban supply and management system. Community water management is related to a remarkable dissociation from the conventional water management exercised by the government. In rural communities, water management is based on community organizations, particularly water committees (Casas, 2015). Rural life involves a particular communal existence, in which individuals and communities are linked with nature, taking sociocultural actions and generating community organization around natural resources, mainly water (Quecedo and Castaño, 2002).



Rural communities, particularly those located in remote and marginalized regions, use their economic, technical, and human resources to tackle water supply requirements. Given the extremely local nature of these problems, they are seldom taken into account by the government and, consequently, this situation results in the self-management of water. Unlike the conventional water management in urban centers, community water management seeks a fairer water access among its members, even if those conditions sometimes involve water scarcity. Meanwhile, if external individuals try to take over this resource, the locals collectively defend their communal right to water (Sandoval and Günter, 2015).

Given the water-related environmental problem faced by rural communities, the inter-community cooperation and the cooperation with government institutions and academia is fundamental to improve community self-management. Such strategy would build participatory dialogues and actions for water management, based on the different social dimensions (importance, exploitation, and preservation) of water, with the aim of achieving a sustainable-compatible management for towns and communities (Foladori, 1999). The forms that communities use to organize their access to water must be discussed. These forms depend on land ownership, location, number of users, and the regional intercommunity history of the localities (Almagro and Venegas, 2009). Therefore, this research deals with the organizational complexity of eight communities of the municipality of Ixtacamaxtitlán, located in the Sierra Norte de Puebla. The objective was to identify the organizational forms of the community water management, taking into account the dialogical factors that the communities use to build their- water-based community links.

MATERIALS AND METHODS

Eight localities (auxiliary boards) of the municipality of Ixtacamaxtitlán, Puebla, were studied. The municipality of Ixtacamaxtitlán is located at 19° 27' and 19° 45' N and 97° 41' and 98° 03' W, at 2,000-3,400 m.a.s.l. The climate is subhumid temperate with summer rains. The region has leptosols, phaeozem, and lovisols (INEGI, 2010).

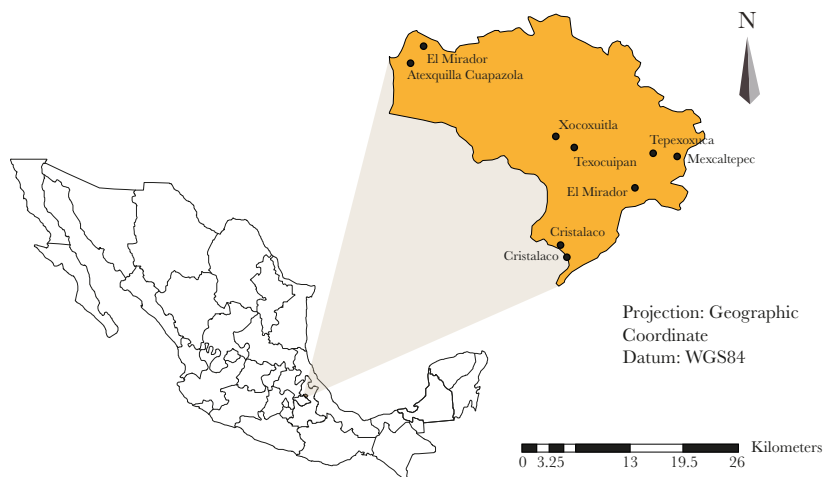


Figure 1. Location of the study area.

Data collection

In order to address the local water management problem, an action research approach was carried out (Fernández and Johnson, 2015). The collection of truthful data through traditional methods was not possible, as a consequence of the location of the study area and the environmental conflict background, related to the exploitation of water and mineral resources. The action research includes both qualitative and quantitative data and, consequently, was considered similar to mixed methods (Creswell, 2012). As part of the study, the research team observed and took part in the following activities: maintenance of pipelines, springs, and channel paths community meetings regarding drinking water and irrigation units; and restoration of channel infrastructure. In addition, community workshop and training activities were carried out. During these activities, the research team shared information leaflets about rights, duties, and sanctions regarding water and other natural resources. In addition, a PowerPoint presentation and videos were included, as part of a collective reflection process about the local water problem.

During the participation of the research team in these activities, authorities, former authorities, and current and former water committee members took part in semi structured interviews. The interviewees included: eight water authorities; eight former water authorities; 40 members of the irrigation committee (a chairperson, a secretary, a treasurer, and two assistants of the auxiliary boards); and 80 members of the irrigation committees from two previous periods. The interview guide was made up of the following variables: auxiliary board to which the interviewee belongs, water source access, water source name, length of use, participation in community committees (position), women participation as water users, awareness about water concessions, land ownership, water management differences between ejidos and small private properties, technical support, local organization, communal regulations about water use, water management, water use conflicts, water abundance or scarcity, and opinion about alternatives for the preservation of natural resources. In addition, data about water supply sources, communal name of the source, fees, land ownership, number of users, and year in which the supply source management started were collected from the community archives.

Data analysis

The information was systematized based on the records gathered from each auxiliary board and each community of the study. The tables provide information about water sources and community organization. The data obtained from the interviews were analyzed according to the subject.

RESULTS AND DISCUSSION

Community water sources and use characteristics

Springs are the water source of most of the communities (Table 1). Four communities (Xocoxiutla, Texocuixpan, Cristalaco, and El Mirador) share the same water supply source (Cerro Grande spring) and have a total of 1,196 users. This source is located in small private properties and, along with the Tzompantla spring, is one of the oldest water exploitation sites of the area. The fees go from MXN\$100 to MXN\$1,600 per year. In the case of Cerro

Table 1. Water source per auxiliary board. Source: Table developed by the authors.

Community	Water source	Community site name	Water tariff	Land tenure	Number of users	Start date of management
Tepexoxuca	Manantiales	Acatmaniteno	100 Mexican pesos per year	Private	16	1996
		Acatmanitzontan			24	1990
		Tipalan			270	178
Xocoxiutla	Manantial	Cerro Grande	450 Mexican pesos every six months	Private	192	1960
Texocuiupan	Manantial	Cerro Grande	360 Mexican pesos every six months	Private	356	1961
Cristalaco	Manantial	Cerro Grande	480 Mexican pesos every six months	Private	269	1980
El Mirador	manantial	Cerro Grande	200 Mexican pesos bimonthly	Ejido	379	1977
Mexcaltepec	Pozo	La Unión	800 Mexican pesos every six months	Ejido	473	1986
Atezquilla	Pozo	Atezquilla	700 Mexican pesos per semester	Ejido	511	1976
Cuatexmola	Manantial	Tzompantla	240 Mexican pesos every six months	Ejido	221	1960

Grande, the annual fee is different for the users of the different auxiliary boards. Well water users pay higher fees, as a result of the higher operation cost of the supply system. These water fees fall into the range reported by Sandoval-Moreno and Günter (2013) for the rural communities in Jalisco (MXN\$550-MXN\$1,900 per year).

Ejido water management

Based on land ownership, water management has different characteristics in the communities. Ejidos are not just a land ownership type; they also are a particular community and collective organization, that includes water management. Therefore, the use of the natural resources found in ejidos is seen as a human right. Nevertheless, Ayala (2005) pointed out that this is not a right per se, but rather a personal and social duty. The water fees are relatively low; however, fees are compensated to a certain degree when users support the different water management activities.

Unlike water management in private properties, water plays a social cohesion and participation role in ejidos. Water users are more organized and they reach agreements by consensus. Consequently, as traditional participation forms, community meetings are fundamental to follow-up the resulting agreements. In Puebla, this decision-making body reaches consensus, which have a socially primary role in the communities (Reidl, 2012).

A high attendance and expression of opinion were found not just in the meetings, but also in water management community activities. According to these opinions, users timely pay water fees and are collectively open to look for any technical support they require.

Although the ejidos have different water fees, they share a social and participative water management. Water management capacity is a condition developed by towns, based on their internal dynamic and language: community codes are used to communicate with each other and gain access to water. Usually, those codes imply the compliance with certain duties. Consequently, the inhabitants of the region reach agreements in traditional ways (community meetings). The inhabitants themselves call or break up the social participation for any community work that must be done, because they know each other. This phenomenon suggests an arrangement of individuals with a similar mindset and interests. This type of logic usually leads to a power dynamic, where some individuals are more influential than others (Salgado, 2012).

Water management in small private properties

Some water bodies (such as springs) are located within private properties and, in most of the cases, owners do not share them with the rest of the community. For example, two private properties of the San Andrés Tepexoxuca community have springs; however, owners only use water for domestic purposes and do not share it with some nearby families that might need it. The rest of the inhabitants of the community get water from collective springs. Unfortunately, the number of users increases every year, reducing the capacity of the springs to appropriately meet the demand. In addition, the low rainfall rate of the last few years has become a growing concern for the population: they think it is not enough to recharge the springs. The inhabitants are aware of the important role that rain patterns play in water availability. According to the interviewees, the population has enough water during the rainy season, because they collect and store water from house leaks and the springs have a greater water volume. Meanwhile, the spring owners also have access to drinking water from the public water network and, consequently, they have greater water availability. Nevertheless, some owners are willing to share water from their springs with other inhabitants of the community. Members of the community said that this is a sign of humanity from the said owners. According to Abello (2009), more and more inhabitants of the localities are aware of the Ley de Aguas Nacionales. This law establishes that water is a property of the nation and, therefore, public service should be always favored over private water service.

Regarding the irrigation water management, private owners make a more rational use of water in some places. This situation is a result of the highly-efficient irrigation systems—such as pressurized underground irrigation and subsurface drip irrigation systems—employed by land owners.

Water management community organization

Table 2 shows the organizational variables related to community water management. Variations depending on social participation, water availability (domestic and agricultural use), and ongoing conflicts are the main cause of multi-communal social cohesion. In

the communities under study, different organizational degrees regarding irrigation and drinking water were recorded. The local authorities of each management structure can occupy different positions such as *tepanero*, water carrier, pump leader, warden, irrigation secretary, drinking water chairperson, irrigation chairperson, network warden, and fee collector. Although the titles are different in every community, their duties are very similar. Based on the water availability of each community, the positions are established per hours, days, weeks, or as a permanent position (Table 2). The positions have been established to guarantee that all the members of the communities receive the same amount of irrigation and drinking water.

A major feature of community water management is the inclusion of women, both as users and decision-makers. Based on the accountability of water committee positions

Table 2. Water management community organization.

Auxiliary boards	Roles en la distribución del agua	Roles in water distribution	Type and frequency of conflicts	Forms of community brotherhood
Tepexoxuca	Drinking water: Permanent	Mostly men	Damage to the pipeline	Not present
	Irrigation: 3 days, every 15 days per user		2-3 times a year	
Mexcaltepec	Drinking water: pumping every 4 days	Mostly women	Energy surcharges por late payments	Collaboration for forest restauration
	Irrigation: not available		Once a year	
Texocuixpan	Drinking water: pumping every week	Mostly women	Damage to the pipeline	Share trainings
	Irrigation: not available		3 times a year	
Cuatexmola	Drinking water: permanent	Mostly women	Damages to reservoirs	Collaboration against fires
	Irrigation: each week		1-3 times a year	
Cristalaco	Drinking water: every 3 days	Mostly women	Late payments	Collaboration against fires
	Irrigation: not available		4 times a year	
Atexquilla	Drinking water: pumping every 4 days	Mostly women	Damage to pipes	Donation of pumping equipment
	Irrigation: every 20 days		Once per year	
Xocoxiutla	Drinking water: pumping every 2 days	Mostly women	Damages to reservoirs	Support for cleaninf of tanks and pipes
	Irrigation: not available		Once per year	

and performance, a higher transparency regarding community economic resources was detected when women were in charge of the committees. According to Moscoso and Ortiz (2020), this is a key element for an improved water management that should also lead to the full inclusion of rural women in the management and decision-making processes of water organizations.

Water conflicts are frequent between users and communities, including clandestine water intakes and self-assignment of water volumes. Nevertheless, community brotherhood and sisterhood links develop in time, as a result of the distribution, preservation, and defense of water resources.

Water scarcity and adaptation strategies

Well water users from ejidos are more concerned than water spring users about the scarcity that could result from water depletion. Some users employ rainfed cultivation systems in their lands and they pointed out that they would like to change it for another irrigation system to avoid water scarcity. In some regions where water is scarce, people store it in cement or plastic containers to prevent evaporation. Meanwhile, in places where rains are very scarce, people usually work as construction workers, carpenters, blacksmiths, or shepherds, instead of growing vegetables.

Forest exploitation and its relationship with water

Ejidos manage forests based on their internal regulations, which rule the exploitation of common land and resources. Ejidos have governmental authorization for this type of exploitation. The Comisión Nacional Forestal (CONAFOR) is in communication with the regional ejido authorities to regulate and supervise forest exploitation and management. The interviewees are aware that the forest must be exploited depending on the age of the trees. The ejido forests occupy relatively small areas: the Mexcaltepec ejido has 739 ha, El Mirador has 943 ha, Atezquilla has 957 ha, and Cuatexmola has 1,346 ha. Five forest exploitation authorizations were identified in the following hills: Almeya, Cruz de León, Cerro Grande, Timimi, and La Fábrica.

In the case of community forests that are not found in ejidos, the interviewees indicated that the community itself own the forest. In order to exploit forest resources, the civil authorities call a meeting to inform the community that trees must be felled to meet a community need. Consequently, the community creates commissions whose members are in charge of the required tasks. The local population take part in collective activities such as making boards or planks from the trees that are cut down in the forest (Comisariado ejidal Tlalmotolo, 2023).

Community forest exploitation only takes place if the need for timber cannot be met any other way. This is an atypical and infrequent type of exploitation —unlike the ejido exploitation, which involves a relatively frequent management and exploitation. Consequently, forests under community management have more possibilities to regenerate than forests located in ejidos. However, unless a collective need justifies felling trees of an exploitable age, no cutting will take place without the permission of the community meeting.

The schools of the region try to raise awareness in children, youngsters, and adults about the importance of the preservation of forest resources for water conservation. The inhabitants of the communities are aware of the importance of maintaining the forests in good shape to guarantee the recharge of springs and wells. Most of the communities understand the importance of forest preservation and protection. Nevertheless, strong differences were found regarding the actual actions taken to protect the forests. In some localities, the owners of small private properties with small forest areas are concerned about the preservation and restoration of forests. In other communities, where most of the people own plots with hills, stopping excessive logging is not a concern. They argue that they can do whatever they want with their properties. This type of behavior is normal in communities with large forest areas, located at 2,700 m.a.s.l. The forest is the most important natural space in the municipality of Ixtacamaxitlán. Given the semiarid conditions of most of the municipality, this situation is also a source of concern (Comisariado ejidal, Cuatexmola, 2023).

CONCLUSIONS

In the study region, community water management is based in organizational structures, collective participation forms, and individual traditions, in which women are not yet fully included as users and decision-makers. The diversity of the local water management is associated with the type of ownership of the land in which water sources are located, the type of supply source, and the availability of recharge areas (forests).

Ejidots allow users greater access to water sources than small private properties. The former is considered as a collective resource, while the latter is a private resource. The supply source type influences water fees: well water users pay a higher fee than water spring users.

ACKNOWLEDGEMENTS

The authors would like to thank the civil and community authorities that, based on traditions and local regulations, allowed them to carry out the study. The authors would particularly like to thank auxiliary board chairpersons, ejidal commissariats, community meetings, inspection wardens, and the population of the communities.

REFERENCES

- Abello, L.R. (2009). La investigación en ciencias sociales: sugerencias prácticas sobre el proceso. *Investigación y Desarrollo*, 17(1), 208-229. ISSN: 0121-3261. Disponible en: <https://www.redalyc.org/articulo.oa?id=268/26811984010>
- Almagro Vázquez, F. y Venegas-Martínez, F. (2009). Crecimiento y desarrollo con sustentabilidad ambiental. Un enfoque de cuentas ecológicas. *Economía y Sociedad*, XIV (23), 79-103.
- Ayala, D. C.A. (2005). Margarite Yourcenar: el método histórico y la literatura. *Anuario Colombiano de Historia Social y de la Cultura*, (32), 309-315. ISSN: 0120-2456. Disponible en: <https://www.redalyc.org/articulo.oa?id=1271/127113735012>
- Casas, A.F.C. (2015). La gestión comunitaria del agua y su relación con las políticas públicas municipales. El caso del manantial de Patamburapio en el estado de Michoacán, 2009-2014. *Intersticios Sociales*, 10, 1-43
- Creswell, J.W. (2012). Educational research: planning, conducting and evaluating quantitative and qualitative research; 4a ed.; Editorial Pearson; Boston, MA; 650 p.

- Delgado-García, S., Trujillo-González, J., & Torres-Mora, M. (2017). gestión del agua en comunidades rurales; caso de estudio cuenca del Río Guayuriba, Meta-Colombia. *Revista Luna Azul*, (45), 59-70. <https://www.redalyc.org/pdf/3217/321753629005.pdf>
- Fernández, M. B. y Johnson. M.D. (2015). Investigación-acción en formación de profesores: Desarrollo histórico, supuestos epistemológicos y diversidad metodológica. *Psico perspectivas*, 14(3), 93-105. ISSN: 0717-7798. Disponible en: <https://www.redalyc.org/articulo.oa?id=1710/171042264009>
- Foladori, G., (1999). Sustentabilidad ambiental y contradicciones sociales. *Ambiente & Sociedad e*, (5), 19-34. <https://www.redalyc.org/pdf/317/31713413003.pdf>
- INEGI (2010). Compendio información geográfica municipal 2010. Ixtacamaxtitlán, Puebla. https://www.inegi.org.mx/contenidos/app/mexicocifras/datos_geograficos/21/21083.pdf
- Martínez-Moscoso, A. y Ortiz, A.A. (2020). Las guardianas del agua y su participación en la gestión comunitaria de los recursos hídricos. Un análisis de la normativa ecuatoriana. *Foro*, 34, 61-84. DOI: <https://doi.org/10.32719/26312484.2020.34.4>
- Quecedo, R. y Castaño, C. (2002). Introducción a la metodología de investigación cualitativa. *Revista de Psicodidáctica*, (14), 5-39. ISSN: 1136-1034. Disponible en: <https://www.redalyc.org/articulo.oa?id=175/17501402>
- Reidl, M.L.M. (2012). El diseño de investigación en educación: conceptos actuales. Investigación. ISSN: 2007-865X. Disponible en: <https://www.redalyc.org/articulo.oa?id=3497/349736284008>
- Salgado, L.A.C. (2007). Investigación cualitativa: diseños, evaluación del rigor metodológico y retos. *Liberabit Revista Peruana de Psicología*, 13, 71-78. ISSN: 1729-4827. Disponible en: <https://www.redalyc.org/articulo.oa?id=686/68601309>
- Sandoval, A.M. y Günter, M.G. (2015). Organización social y autogestión del agua: Ciénega de Chapala, Michoacán. *Política y Cultura*, 44, 107-135
- Sandoval-Moreno, A. y Günter, M.G. (2013). La gestión comunitaria del agua en México y el Ecuador: otros acercamientos a la sustentabilidad. *Ra Ximhai*, 9(2), 165-179. <https://dialnet.unirioja.es/servlet/articulo?codigo=7870297>

