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# Making Informal Water Distribution Work: Collective Agency and Self-Organization in Informal Areas of Xochimilco, Mexico City

RESEARCH ARTICLE

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## ABSTRACT

Global environmental change can disproportionately impact vulnerable populations in informal settlements already struggling with diminished access to resources, conditions of poverty, and other inequalities. Simultaneously, climate variability is projected to increase global water scarcity and make “formal access” to water (i.e., through gray infrastructure sponsored by a centralized government) not only politically unlikely but also physically unfeasible. Cities will need alternative ways of delivering water to informal settlements that are reliable, sufficient, affordable, environmentally efficient, and fair. Using data from two informal settlements in the Xochimilco Municipality (Mexico City), we explore current informal arrangements for water access and delivery, and what roles are played by governments, water truck drivers, and residents. We found that self-organization through collective agency and community leadership were key for effective water delivery through private or public water trucks (*pipas*). One community showed stable leadership and strong collective agency, resulting in more “efficient” public water delivery and low levels of consumption of water from private sellers. In the other community, collective agency was hindered by lack of clear leadership and self-organization, causing residents to resort to individual action (i.e., buying more private water) rather than collectively organizing to gain sufficient public access to water. Our findings suggest that collective agency enables a positive feedback loop between water truck drivers and residents which allows efficient distribution with minimum public investment from the municipality. We argue that the explicit acknowledgement of the role of collective agency and its adequate compensation to create new agreements would create opportunities for more sustainable alternatives of water delivery in communities trapped in informal regimes of water distribution.

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informal urbanization; self-organization; collective agency; water supply; Mexico City

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## 1. INTRODUCTION

The formality/informality construct and urban illegality and exclusion discourses have been used to justify the inaction of power structures in the water sector (Mudege & Zulu 2011; Lerner et al. 2018; Hernández et al. 2021). The notion of informal urbanization legitimizes public agencies to overlook their duty to protect the human right to water while burdening residents of informal areas with responsibilities for basic services provision. In practice, though, the right is often protected,<sup>1</sup> but the formal/informal dichotomy allows to partly transfer the cost of water provision from the public formal sector onto the “informal” residents. Residents of informal settlements cannot legally demand water.<sup>2</sup> Water provision is thus achieved with minimal economic and political intervention from the State as residents take individual and collective actions to ensure irregular access to public water sources, for example, when residents organize collectively to demand better access to these sources (Dusen 2016; Eakin et al. 2016). In addition to relying on collective action to reduce water delivery costs, government entities instrumentalize collective action politically by trading access to basic services with certain groups of residents in exchange for electoral support (Gilbert & De Jong 2015; Lerner et al. 2018). As a corollary, collective action, and its role through the self-organization in water provision in informal settlements, explains both why certain settlements have better access to water than others, and how these settlements are integrated into formal power structures (Ranganathan & Balazs 2015).

Given the role of collective action to face water scarcity in informal areas, it is important to understand how and where the capacities for these actions emerge, and we use the concept of collective agency to explain them. We define collective agency as the capacity of a group of people to organize to make collective choices, act on these choices, and influence their future situations and resource distribution. Collective actions are specific actualizations of collective agency. This definition of collective agency implies a relationship, thus indicating the relational nature of collective action (Lotz-Sisitka 2018). In this sense, collective agency can reflect the capacity of groups to shape their own destiny in terms of acts that are determined by communal values and social structures (Crocker and Robeyns 2010; Pelenc et al. 2015). Collective agency can emerge for several reasons; in the case of informal areas collective agency is exercised to reduce water scarcity or access other public services, but it usually implies a relational process of self-organization and leadership. In this sense, Correa et al. (2018) argue that self-organizing processes entail actions and practices within a collective to adopt coordinated strategies with the aim of obtaining

better common benefits or to reduce damages, and authors such as Ostrom (1990) identify leadership as a one major variable of self-organizing processes. From the standpoint of our relational approach to collective agency, leadership is a key type of relationship based on trust, empathy, accountability and recognition between the leader, and the collective. The leaders' key role consists of interfacing the collective with external actors and authorities.

Despite international agreements on access to basic needs such as water (WHO 2011) or access to decent housing (UN-Habitat 2015), self-organization fills gaps in top-down governance, particularly in informal areas where citizens do not have their rights legally protected. On the one hand, it can increase informal residents' water security by enabling mobilizations that press authorities to deliver water under circumstances of prolonged scarcity (Eakin et al. 2020; Lejano 2018; Bisung et al. 2014). On the other hand, collective agency can facilitate a more fair and efficient distribution of water within the community through the residents' self-organization. We argue that this self-organization could facilitate the work of local governments by partially freeing them from the responsibility of internally distributing the water that is delivered to the community. In this sense residents become the agents who effectively maintain water services systems, with collective agency shaping the way informal neighborhoods manage water supply services. This is important because the explicit recognition, support and promotion of collective agency through self-organization could be a win-win proposition for authorities and residents when formalization is unlikely, as well as a lever to advance greener alternatives as long as legal framework permits (Manuel-Navarrete et al. 2019). For example, the acknowledgment of collective agency can be thought of as the establishment of new water supply agreements between residents and local governments, such as “more pipes”, “collective container” or “rainwater capture system” (Hernández et al. 2021). Also, this agreement should include rights and responsibilities for all participants, authorities, leaders and residents.

Mexico City is a paradigmatic case to examine the role of collective agency in achieving water security in informal settlements. The city is highly dependent on extractions from the Valley of Mexico aquifer, which has been overexploited for decades but still provides 58% of the total water consumed in the city. The other 42% comes from the Cutzamala and Lerma systems outside of the city, which are hydraulic systems for storage, conduction, potabilization and distribution (SACMEX 2018). According to Mexico City's Water Ministry (SACMEX 2018), 98% of Mexico City's population is connected to the drinking water network infrastructure, but 18% of this group does not receive a daily supply even though it has gray infrastructure, such

as dams, pipes or water treatment plants. The 2% without network infrastructure are mostly informal settlements, which are supplied exclusively by water trucks (*pipas*). Using two informal communities in the Xochimilco Municipality in Mexico City, this study explores the role played by self-organization and collective agency, and the importance of formally recognizing and supporting this role, to ensure effective and efficient water supply in marginalized areas that are trapped in partial water access regimes. In our case, high efficiency in water distribution is achieved by the capacity of the community to self-organize to collectively purchase water from a private well, or arrange that the government sends water trucks. Efficiency decreases when individuals have to buy private water bottles. We found that a key mechanism that could allow a positive feedback loop and reduce the cost transfer of access to water in informal areas consists of recognizing and properly supporting, instead of relying on, the leadership and self-organizing capacities of a community: its collective agency.

## 2. THE IMPORTANCE OF COLLECTIVE AGENCY AND SELF-ORGANIZATION IN INFORMAL URBAN AREAS

Collective action and self-organization have been identified as a mechanism for alleviating water shortages in marginal urban areas around the globe (Enqvist et al. 2016; Correa et al. 2018; Streule et al. 2020; Dennis and Brondizio 2020). Examples in urban contexts include movements that emerged in the 1980s in Mexico City, which demanded improvements in infrastructure and the quality of drinking water services (Castro 2012; Cabestany 2014), as well as new social movements for the human right to water (Becerra 2012). Other examples come from flooding events, where self-organization has been central in demanding new infrastructural investments or in creating groups to clean houses during extreme events (Eakin et al. 2016). More generally, collective action has been widely discussed in the production of space and urban informality literature (Caldeira 2017; Streule et al. 2020).

A community's collective action in informal areas can be key to many of these settlements gaining a kind of right of access to urban services such as water, sanitation and electricity (Tellman et al. 2021). In Kenya, for example, women's collective interventions improved water management and access based on local practices and knowledge (Bisung et al. 2014). Meanwhile, in Mexico City, social movements in popular informal neighborhoods influenced demand for improvements in infrastructure and the quality of potable water service (Castro 2012; de Alba and Hernández 2014). In these cases, the manifestation of

collective agency is incorporated within power structures as a driving force behind decisions on the provision of public services in informal areas through collective action. In turn, the collective capacity of communities affects the way they are recognized and, therefore, the way the government provides public services such as water. Collective agency may spontaneously emerge from the pressure and demand for access to water, but it does not guarantee that the demand will be met, and sometimes unequal power relations are maintained with the state because collective agency is not recognized (de Alba & Hernández 2014; Cabestany Ruiz 2014). Collective agency can also emerge when a group understands that their basic human rights such as the right to water are not respected, in other words, when they perceive social injustice.

Collective action is often associated with social movements seeking to influence decisions on the provision of public goods through contention politics. Contention-based strategies have been studied from a rational-choice perspective. Authors such as Olson (1965) state that collective action is a rational choice that is achieved when the members of a group or organization perceive the costs of their actions as lower than the benefits; when they come together to satisfy their individual needs to achieve a common goal (Galafassi 2011; Olson 1965). However, recent critiques of this approach, such as Jasper (2012), point out that some of these ideas ignored cultural meaning and the personal emotions that emerge in strategic actions of social movements. In other words, there was an absence of action theory to understand how actors decide to participate, and the dimensions of personal or collective desires.

In the case of access to water in cities, collective action can take the shape of social movements, or groups of pressure (Cadena-Roa 2015). Groups of pressure are created from the lack of state action to guarantee access to public services. Residents act as an organized group to address the lack of water or insufficient service establishing self-organization for the search for water, the monitoring of resources, the management of resources and the preservation of minimal amounts of water (Kähkönen 1999; Bisung et al. 2014; Correa et al. 2018). A characteristic of these groups of pressure is that they are organized groups that handle policy deficiencies by themselves, while other times they are organized to get political control, although this is not always necessarily the case. On the other hand, social movements for water access emerge when people demand access to infrastructure, high standards of water quality, and when people observe changes in water governance. For example, there is more social mobilization during water scarcity or changes in the cost of water (Castro 2012; Kloster and De Alba 2007; Cabestany 2014).

In Mexico City, there was an urban social movement called “Movimiento Urbano Popular (MUP)”,<sup>3</sup> where collective action emerged to address social inequalities related to access to public services, particularly the access of housing (Álvarez 2019). During the 1980s in Mexico City groups such as MUP demanded housing and public services and filled the lack of opportunities for poor people, creating a new informal urbanization that eventually was formalized. Thus, we argue that in the case of access to public resources such as water, there is agency (freedom) to decide to act collectively to face lack of water. However, in this study, we do not consider our case-study as formal examples of social movements or groups of pressure because they are not formally recognized or supported; instead, we argue that these groups are a hybrid between groups of pressure and social movements. We define them as an informal social group that operates the water management system in the urban periphery. In other words, the case-study groups self-operate the water informal system using their collective agency.

In this analysis we understand collective agency as the manifestation of capacities that allows a group of people to act together to achieve their own future, for example, sharing a same interest or goal, such as access to water, through internal organization (agency-leadership), the capacity for self-organizing public services, and the interaction with government (Comeau 2010). Leadership emerges from self-organized processes when well-reputed community members acquire greater influence because the community trusts them to support self-organization processes, and represent the collective in front of the authorities. In our case, the large majority of leaders were women, either employed as domestic workers or full-time homemakers. Some leaders reported that their main motivation stemmed from their empathy towards the most vulnerable members of the community. For instance, a turning point for one of the leaders was seeing older people having to carry water for long distances. As far as we know, leaders do not benefit economically or politically. Their main reported reward was the recognition by the community, and the establishment of friendship relations with some government officials. The lack of economic and political recognition might explain why effective leadership did not coalesce in one of the communities.

In informal settlements, governments may allow and benefit from collective agency, without formally recognizing or supporting it. This happens because the agency normally responsible for water supply and/or other basic services is not legally accountable (Caldeira 2017; Lerner et al. 2018). When people organize to search for water because the service fails, they coordinate actions that maintain sufficient access to public services with minimal or reduced government intervention. On the bright side,

collective agency has the potential of transforming the logic of informality into new forms of sustainable access to water supply, such as the use of green infrastructure with fewer environmental impacts (Wolfgramm et al. 2015). In our case study this included collective containers or rainwater harvesting systems (Hernández et al. 2021). As a result, the logic of informality can generate new modes of water distribution (Caldeira 2017; Correa et al. 2018).

### 3. URBAN INFORMALITY AND THE ACCESS TO PUBLIC SERVICES IN MEXICO CITY

Informality is often defined and studied in contrast with what is considered formal, legal or permitted. Historically, the idea of informality has developed from economic and territorial perspectives. In the 1970s, informality was conceptualized as a survival economy (Herrle and Fokdal 2011), associated with economic discourses of developing countries that were linked to urban poverty. Starting in the 1990s, the concept of informality was adopted by architects, planners, and urban experts to denote “unplanned” and “illegal” settlements. Both conceptualizations understand informality as something opposite to the formal, official and/or permitted by urban institutional regimes. Therefore, in urban studies informal settlements have been analyzed from two main perspectives: as a manifestation of economic and social marginalization and, thus, the concentration of urban poverty (Davis 2008), and as part of the urban logic (McFarlane 2012; Roy and Alsayyad 2004; Roy 2012). Similarly, informality has been analyzed as a shortcoming of urban governance in the Global South, as authorities are unable to meet the increasing demand for public services (de Soto 2000).

We understand informality as a mode of space production consistent with neoliberal ideology and intrinsic to certain urban logics that emphasize the economic dimension of public goods management and distribution (Roy and Alsayyad 2004; Roy 2012; Davis 2018). In this view, informality is a product of the neoliberal state rather than a regulation failure (Roy 2012; McFarlane 2012). In other words, an urbanization model that privileges the commoditization of real estate over housing rights, inevitably leads to marginalization, homelessness, or informal settlements. Characteristics such as lack of sufficient access to water, sanitation, land tenure and decent housing are attributes that describe the conditions of urban informality that has become an intrinsic component of many cities (UN-Habitat 2015; Lombard 2014). While informality exacerbates the impacts of climate change, it might also provide flexibility to experiment and leapfrog into the adoption of softer and/or greener infrastructure options as cities respond to these impacts.

In Mexico City the water demand exceeds water supply because water reservoirs are scarce and extracting groundwater is expensive. The government created the “*tandeo*” (meaning taking turns)<sup>4</sup> distribution system to address water demand (GODF 2009). Under this system, households receive water only a few hours during the day or some days of the week, depending on the formal status of land title and political influence of each neighborhood. For example, if the community is formally recognized (with legally-recognized rights to the land) they can demand public services such as water. In the case of informal settlements water is delivered by municipal water trucks, or private water vendors, these residents are not adhered to the *tandeo* system because they are far from public infrastructure (Aguilar and Santos 2011). The *tandeo* system emerged in response to increasing water demand in the periphery of the city. SACMEX decides the allocation rules. Water is generally delivered to settlements, and its internal distribution becomes the responsibility of each neighbor who must be present at the distribution points when the water trucks or vendors arrive or when kiosks are open. It is in this delivery and internal distribution phase where collective agency and self-organization become crucial.

The 2020 assessment of poverty and marginalization in Mexico City identified 1.7 million people living in extreme poverty with several deficiencies, including lack of water and overcrowded housing conditions (EVALÚA 2020). According to the Ministry of Water in Mexico City (SACMEX) there are 358 settlements with a formal *tandeo* water supply system (i.e., gray infrastructure water supply system operating only some hours per day), and 867 informal settlements, exclusively with water trucks supply once or twice per week (SACMEX 2018). The difference between them is that one has formal infrastructure and the other does not, but also because one is located close to pipeline water, and the other is on the urban periphery and farther from water infrastructure. The situation of informality is worsened by the irregularity and uncertainty of the trucks’ schedule, where residents have to spend more resources to meet their water needs than formalized settlers. This uncertainty comes from technical problems such as truck failures or fuel shortages. Residents of informal areas therefore live in a limbo of denial and prohibition and at the same time of arrangements and agreements that only provide unreliable, uncertain, and limited access to certain urban services such as water (Eakin et al. 2016; Lerner et al. 2018).

Informal areas tend to be the last priority due to economic, geographic, and political factors hindering their development (Sinharoy et al. 2019). In Mexico City there are clear asymmetries in the way that the public sector responds to water scarcity (Eakin et al. 2020). Sometimes, the overlap of responsibilities of public services weakens

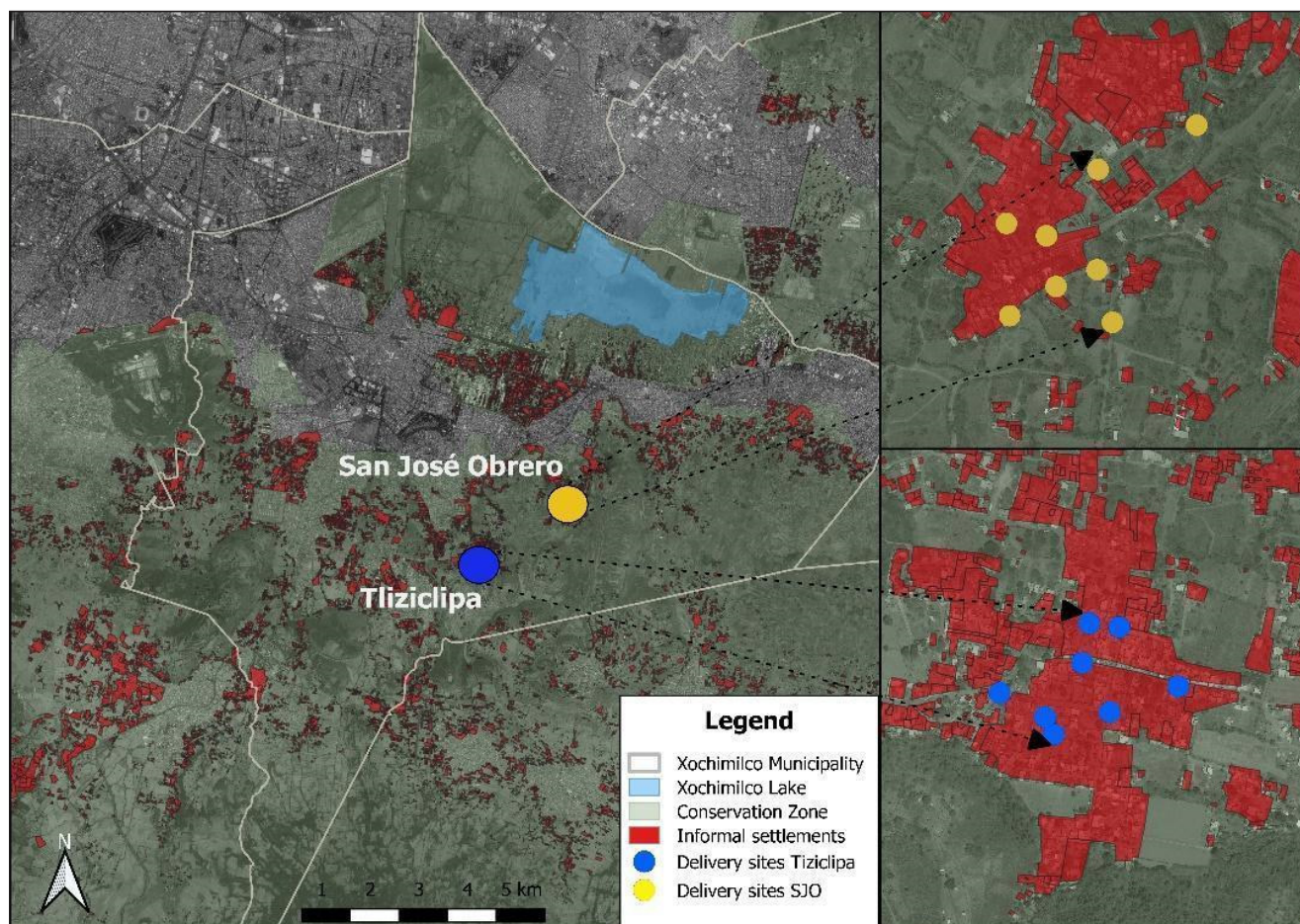
the capacity of communities to demand water (Lerner et al. 2018). Asymmetric and complex power relationships between water providers (public or private) and consumers (citizens), where the providers have control over the water supply, ensure minimum or survival levels of water provision. These power dynamics exist under unequal exchanges, for example, informal residents pay more for water than formal residents and also have to spend time on collective organization and mobilization for water (Eakin et al. 2016; Hernández et al. 2021).

## 4. METHODS

### 4.1 CASE STUDY

Xochimilco is the municipality (*Alcaldía*) of Mexico City with the highest number of informal settlements (PAOT-SMA 2010). The municipality withdraws water from 66 active deep wells within its territory to supply water to its citizens (PDDU-Xochimilco 2005). Urban informality is common in Xochimilco’s highlands, where delivering water is technically more difficult and costlier, plus the provision of public infrastructure and urban services is legally prohibited and almost non-existent. Xochimilco is well known as a municipality with the Conservation Zone.<sup>5</sup> From 2000 to 2010 the number of informal settlements in Xochimilco grew from 169 to 314, and in 2016 there were an estimated of 859 with 480,000 people covering 3,200 ha (Aguilar and López 2009; PAOT-SMA 2010; Tellman et al. 2021). To resolve the land rights of these communities, the local government formalized certain areas, but some of the informal settlements continue to await regularization and access to better public services, such as potable water.

This analysis focuses on two informal communities in the highlands of the Xochimilco municipality: Tiziclipa and San José Obrero (SJO), both communities receive water from public water trucks in delivery sites (*paradas*) (Figure 1). These settlements are located in the Conservation Zone of the Xochimilco Municipality that is a source of environmental goods and services for the inhabitants of Mexico City. In May 1982 the Partial Urban Development Plan for Xochimilco (*Programa Parcial de Desarrollo Urbano de Xochimilco*) was approved, which sets forth the policy of the conservation area, however, the informal settlements have continued to grow (Tellman et al. 2021). San José Obrero and Tiziclipa were formed about 25 years ago and the residents receive water from water trucks provided by the local government. In terms of population size, Tiziclipa has more households (364 houses in 2005, approximately 2,730 inhabitants) than SJO (150 houses in 2005, approximately 1,125 inhabitants), but both are still growing (PDDU Xochimilco 2005).



**Figure 1** Location of case-study communities in the Xochimilco municipality and the water delivery sites (*paradas*).

#### 4.2 DATA COLLECTION AND ANALYSIS

To address the manifestation of collective agency and self-organization in the context of water access, the first author applied a questionnaire and semi-structured interviews at the household level in the two informal communities. Twenty-one responses were obtained from each community from households located along different delivery sites (*paradas*)<sup>6</sup> in each community. Participants were identified using the snowball technique (Bernard 2006); we started with leaders of delivery sites and then they suggested other neighbors in the case of Tiziclipa. In the case of SJO, the community leader organized a meeting with all neighbors and then individuals attending were recruited for the questionnaire. In both communities we were inviting all the neighbors around the delivery sites, not just ones that the leaders recommended. The questionnaire aimed to capture residents' perceptions of self-organization to address water issues, participation in protests for water access, and the process of obtaining water access sheets (*folios*).<sup>7</sup> In addition, the first author conducted semi-structured interviews with the leaders

of the delivery sites; in the case of SJO the leader of the community was also interviewed. Interviews were also conducted with water-truck drivers and local authorities about water-truck delivery services (Table 1). The interviews sought to understand the role of collective action in addressing water shortages, specifically the process to access water, the internal self-organization, the importance of agency and its relationship to leadership, and the interaction with government authorities (water truck drivers, municipality officials). They also included questions about possible alternatives for water supply in informal areas (see Hernández et al. 2021).

We describe the manifestation of collective agency of each community by considering self-organization, collective action, and leadership. In particular, we present a qualitative appreciation of the degree of collective agency through the manifestation of certain actions, for example, the self-organization of delivery sites, and the way that water distribution is managed by each community (schedules, supervisory committee, informal meeting). We also include leadership elements, in terms

of how a community leader mobilizes the community to demand water (or not) or the local government and how they mobilize to provide water from water trucks. We also describe briefly the actions that the residents collectively take to face water scarcity.

Questionnaire and interview data were coded within the following categories: 1) leadership, trust and efficiency of leader 2) collective action to combat short-term water stress, through water distribution mechanisms (e.g., water access sheets, water demand in wells, tips for water trucks drivers), and 3) self-organizing capacities to address longer-term water shortages (e.g., participation in protests, creation of supervisory committees, formal meetings, actions to promote infrastructure investments or regularization). We used MAXQDA software (<https://www.maxqda.com/>) to count the frequency of categories based on interview responses. We combined these two broad categories to assess the long- and short-term outcomes

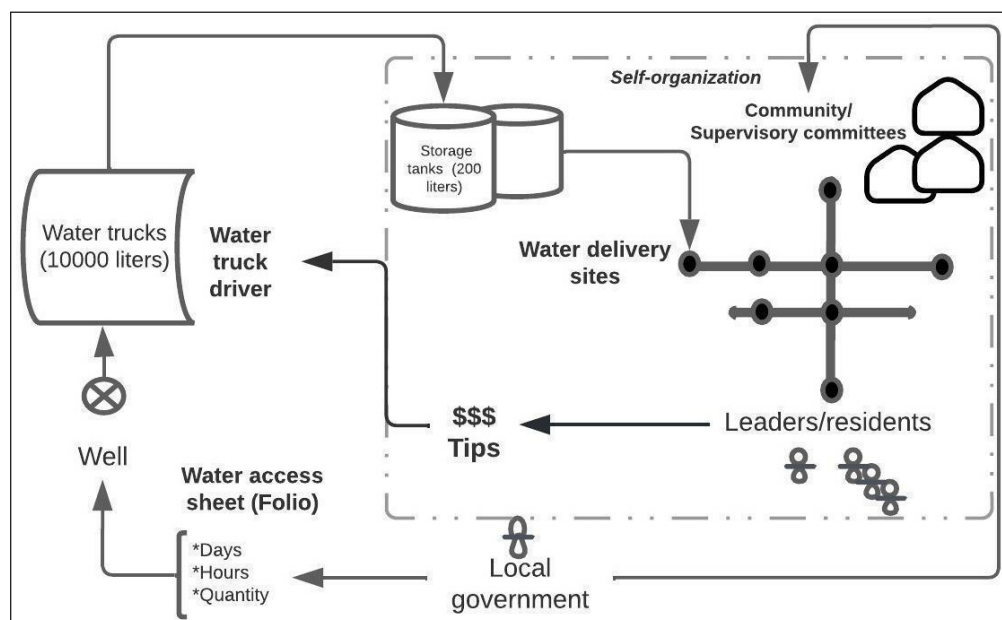
from collective agency in each community. From this analysis we used the most relevant testimonies, which were selected manually to illustrate the results.

## 5. RESULTS

Results reveal that the two communities have a fairly similar informal water distribution system, where water supply is organized through a water registry (*folio*)<sup>8</sup> that facilitates the accounting of distribution in terms of the amount of water per family and therefore the number of water containers allowed per community. We also observe the role of government, public and private actors and residents in the distribution of water, on which the quantity delivered per family and the weekly frequency of service depend. Figure 2 shows the distribution of water in both communities, which is brought to delivery sites, where a

ACTOR (#)	DESCRIPTION
Leader of water delivery sites <i>paradas</i> (8)	Leader of delivery sites SJO (4) Leader of delivery sites Tiziclipa (4)
Xochimilco Municipality (Local government) (7)	Water truck drivers (4) Urban department (1) Land tenure department (1) Potable water and water trucks services (1)
Residents (community's members) (42)	Residents Tiziclipa (21) Residents SJO (21)

**Table 1** List of participants in interviews and questionnaires.



**Figure 2** Water truck distribution system in case-study communities.



neighbor responsible for coordinating the filling of storage tanks is present (*tambos*). This process requires community self-organization to assign one person, sometimes randomly and other times voluntarily (supervisory committees). For example, when people live closer to the delivery site where water trucks arrive, the selected volunteers spend time making sure the tank is filled.

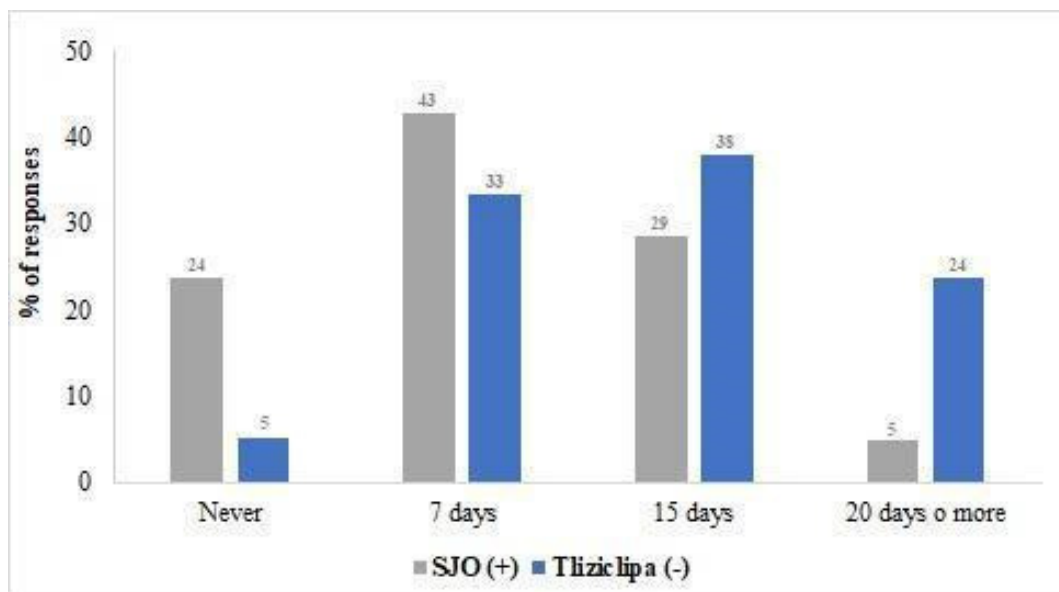
The delivery sites usually have 50 tanks that correspond to 25 families per site. Also, even when the services are free, community members contribute a tip for the driver that is usually around \$10 Mexican pesos (\$.50 USD) per family. Residents believe that paying tips to drivers may decrease uncertainty in the schedule of distribution because drivers will be motivated to come back. The tips work better when there is a leader to collect them from households in the community. Usually, these leaders emerge due to their charisma and good reputation. They are not elected in a democratic formal process. They have other jobs, usually in the informal sector or as homemakers. There is no clear path to become a leader and personal commitment appears to be the most important factor. In the case of the main leader of SJO, she started visiting the Municipality office every day to demand water service after realizing the ordeals from water scarcity were suffered by the most vulnerable members of the community. Then, she started calling her neighbors to join her visits to the Municipal office. People began to seek her out when there was a water problem. Through these dynamics, relationships with community members and with government officials became stronger.

Results illustrate that the main difference in accessing water in these communities lies in the potential for collective action to facilitate access and frequency of water

truck service. While in one of the communities (SJO) the strength of collective agency is based on the community’s capacity for self-organization stemming from a recognized leadership, in the other community (Tiziclipa) the existence of several leaders has divided the community into several groups and therefore, collective agency is weaker, resulting in less frequent water truck service and more frequent private water purchases. In Tiziclipa the presence of many leaders without clear attributions of responsibilities hinders collective agency. These are locally referred to as “ghost” leaders since people are unsure about their actual leadership capacities. In contrast, SJO is organized by a stable leader who specializes in managing the water informal service with the authorities, and the majority of residents feel represented by, and recognize her leadership to supervise the access of water. Thus, the collective agency and resultant self-organized actions are stronger in this community.

In terms of expectations about days with water scarcity, in Tiziclipa (the less organized) 38% of residents mentioned that they generally expect to go 15 days without water and 24% mentioned more than 20 days without water (Figure 3). This result contrasts with the SJO (more organized) community, where 43% of interviewed residents expect seven days without water and only 5% mentioned 20 days or more, while 24% of the responses mentioned never having problems with water. This perception is related to the frequency of water trucks that depend, in part, on strong community leadership, and the manifestation of collective agency.

In terms of collective action, Figure 4 shows the role of self-organization to address a prolonged water shortage. Actions such as going to the well and going to the



**Figure 3** Perception of days with water scarcity among residents (- is less organized and + is more organized) Answers never means that they do not perceive water scarcity.

Municipality’s office to protest are the main actions taken that require the self-organization of residents or leadership, while buying water is an individual action (although they can divide the price among several families but this is not a common action). In Tiziclipa, more than 40% of respondents mentioned buying water while about 20% mentioned going to the Municipality’s office and to the well, respectively. In contrast, in the SJO community 40% respondents mentioned going to the well and to the Municipality’s office to protest, while only 15% mentioned buying water.

The water distribution system in the two case-study communities functions using the capacity of self-organization, leadership and collective action. When collective agency is weak, problems such as long-term water scarcity appear in communities, and more bottled water is individually bought instead of self-organizing to obtain water truck service. Table 2 summarizes the differences between both case-study communities in

terms of leadership and self-organization and resultant impacts for water access and distribution.

As mentioned previously, the expectations about water scarcity depend on how the communities manifest collective agency through collective action. In SJO, the trust towards the community leader has allowed for the organization of weekly water hauling from the water wells (*garzas*), which makes it easier for the water supply to remain stable. Therefore, community members experience fewer periods of water shortage. The community with weaker manifestation of collective agency, Tiziclipa, is affected by fragmented leadership and distrust in the collective action of these self-organization to solve water problems, which in turn impacts the participation of residents in the collective search for water, and thus, the lack of water trucks and longer periods of water shortage is more common, also resorting to buying bottled water (see Table 2).

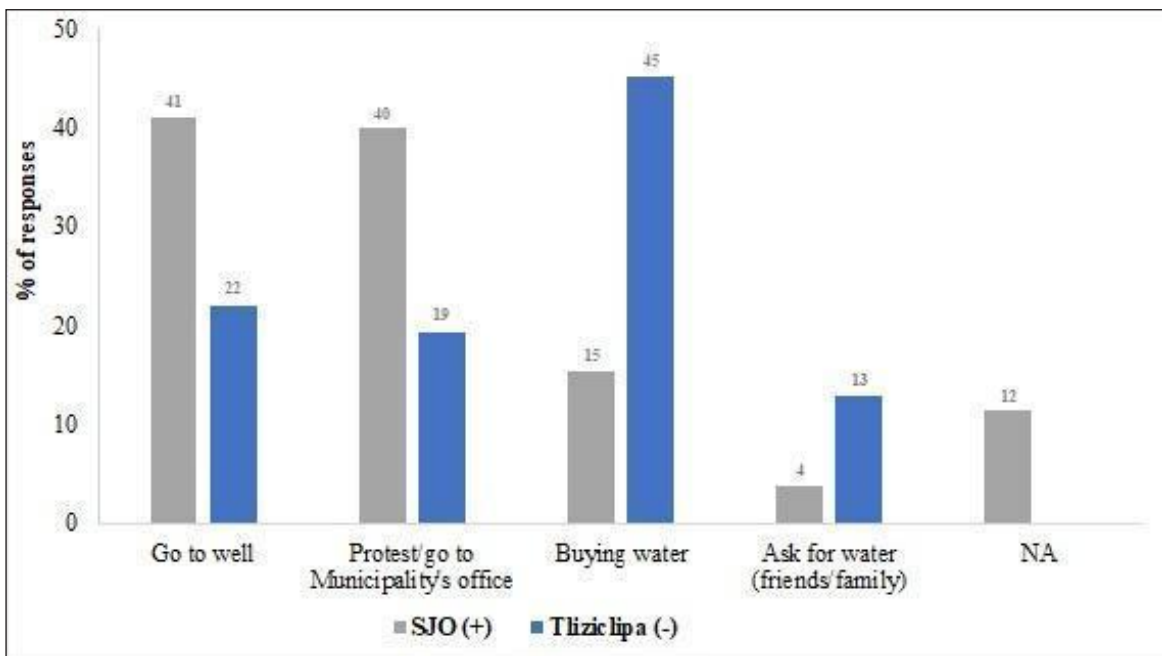


Figure 4 Collective action to address prolonged water scarcity.

COMMUNITY	LEADERSHIP	RESULTS IN WATER DISTRIBUTION AND ACTIONS	DIFFERENCE OUTCOMES IN WATER DISTRIBUTION
Tiziclipa	Several leaders	Expectations about long-term water scarcity	More than seven days
		Actions to face water scarcity	Buying more private water
		Informal initiatives for tips	Each person gives if they want to
SJO	One leader	Expectations about long-term water scarcity	Seven days or less
		Actions to face water scarcity	Protest/mobilization at the wells
		Informal initiatives for tips	Collected by one person

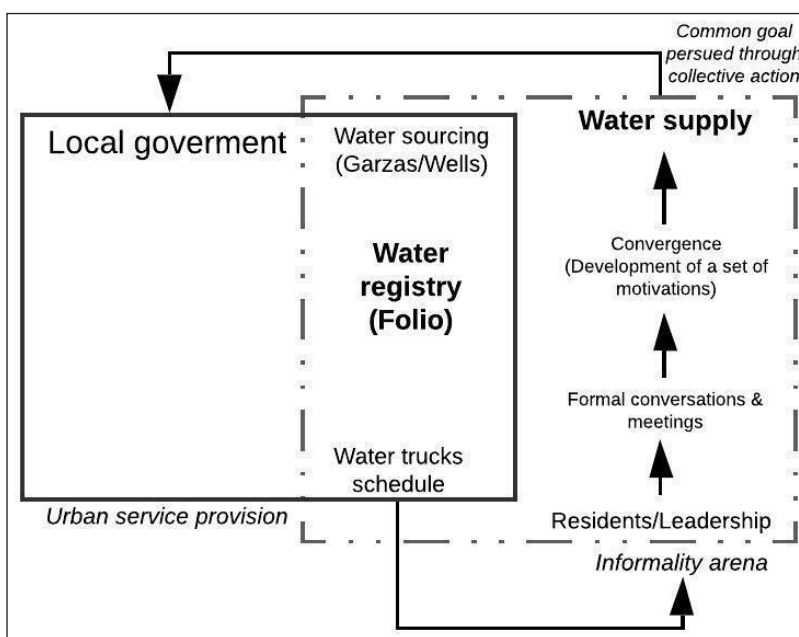
Table 2 Collective agency and its associated impacts in water in the case-study communities.

In SJO, residents explain that having a leader is very important for the process of getting water: “it is very important because people in leadership positions know how to ask the government for water” (emphasis added). Residents perceive that they do not have the communication skills necessary for an interaction with the government, so it is critical to have leadership that can interface with the government and make requests in an effective way. In contrast, in Tiziclipa, some interviews mentioned that the leadership negatively affects them since community leaders “...only take the money from the community and then don’t do anything to solve the issue of water scarcity.”

In both study cases the water supply informal system works, but self-organization was clearer in communities with strong leadership and this had an impact in the frequency of water distribution. That is the case of informal meetings or sudden actions to face the lack of water trucks. For example, in SJO the community organizes to search for water when water trucks do not arrive after one week. One leader expressed that: “... we already know the day when the water truck should arrive, and if we do not see it, for example, today is Wednesday and it does not arrive in the morning, which is when it usually arrives, in the afternoon we are figuring out what to do, if we go to the *garza* [well] or to the Municipality office [for water trucks]”. In contrast, the residents of Tiziclipa respond to the same situation by relying on individual actions rather than working along with neighbors. One leader commented: “I buy water, almost all of us buy water, and we do not go anymore [to wells] because everybody passes the buck, one person goes but the other does not, so we do not go anymore”.

Initiatives such as providing tips work well when there is a leader or supervisory committee that organizes collection. These tips help to maintain the regularity of water trucks. In SJO, respondents mention that the committee leader of delivery sites is in charge of saving the tip for water truck drivers, and he or she is responsible for looking for water in wells when water trucks do not come. An interviewee from the SJO community expressed that “...when they [the government] don’t bring us water, we organize a meeting, and we go to the Municipality to demand water, we talk to whoever we have to talk to...”. At the same time, the government uses this self-organization to provide the services. As one water truck driver commented, “Here we tell the residents that if today is Tuesday and the water truck does not come, [residents] should come to ask for the water truck at the well.”

Finally, we uncovered a complex relationship between the formalization of water distribution and collective agency in the context of urban informality, illustrated in Figure 5. The formalization of water distribution plays out through a number of formal mechanisms. For instance, the water registry (*folio*) provides an accounting system that helps the government manage both water distribution and population growth. The number of registries for each community is fixed, and they were given by the government when the irregular settlements were established. However, we found that in SJO the leader was able to obtain two extra containers beyond what was allocated in the registries. In the interviews we found that this achievement was only possible due to this community’s high level of collective agency as described in our paper.



**Figure 5** Collective agency in the logic of urban informality water distribution modified from Pelenc et al. (2015).

## 6. DISCUSSION

We found that the informal arrangements for water distribution in peri-urban Mexico City work through the roles of leaders and residents, and how they use collective action in order to maintain the system of water distribution. There is a clear distribution process that involves formal and informal actors; their investment of money or human time in order to get water depends on the extent of the self-organization of residents. Particularly in informal communities, this self-organization manifests itself as collective agency that allows the efficient distribution of water with minimum public investment from the municipality. In other words, the informal systems work because the community's collective agency and self-organization allow and facilitate the work of governments in fulfilling the access to water. Thus, communities that are trapped in complex informal areas normalize these arrangements because informality is a product of the neoliberal state rather than a regulation failure (Roy 2012; McFarlane 2012).

### 6.1 THE IMPORTANCE OF A COMMON GOAL TO SUCCEED IN WATER ACCESS

Individual agency converges into the common goal of accessing water through community self-organization and the emergence of leadership to supervise formal meetings and water supply delivery. Water trucks provide water distribution in a minimal way because the residents and leaders have their own motivation to access water. The informal arena of self-organization has allowed the "formal" urban provision to work through water registries (folio) instead of the deployment of expensive hard infrastructure. Leadership makes the work of local authorities easier as they just engage in minimal efforts to provide water but only when well reputed community members start self-organization. The combination of common goals (access to water) and leadership make coordinated strategies to get common benefits: search for water, preservation of amounts of water, management of water resources (Correa et al. 2018).

Informal urban settlements work in a complex logic composed of social norms, economic processes and political arrangements (Gilbert & De Jong 2015; Lejano & Del Bianco 2018). This can be observed when both communities depend on the same informal water distribution system, but also when one community is more self-organized and can obtain water more easily than the other. Our results show that a well-organized community with high trust in a leader can coordinate strategies to verify that trucks fill the containers to the top, or to call for an informal meeting when water trucks do not show up and to resolve the water scarcity situations that result from persistent no-shows. The

participation of residents in this water distribution system is enhanced through collective agency that facilitates the management of basic resources for a few of the strong self-organized communities or with an efficient leadership (Ostrom 1990; Comeau 2010).

### 6.2 LEADERSHIP & SELF-ORGANIZATION AS KEY ELEMENTS FOR COLLECTIVE ACTION

The two case studies showed the consequences for collective action of different levels of collective agency and self-organization capacities and the key role of emergent leadership (Ostrom 1990; Comeau 2010; Correa et al. 2018). Collective agency through collective action, self-organization and leadership has allowed one of the study communities to provide a relatively reliable and effective water delivery system which is considerably cheaper than the alternative of buying water privately. However, the burden of fetching water falls on organized residents and, therefore, the government fails to fulfill its responsibility as an authority in the provision of public services (Lerner et al. 2018). Although benefits may be unevenly distributed among communities that are more organized than others, self-organization generally provided beneficial outcomes for communities and water services (Pelenc et al. 2015). This means that the public/private sector benefits from collective action, as a manifestation of collective agency.

Leadership has been one of the strongest drivers for getting water and other public services in informal settlements in the world (Correa et al. 2018; Streule et al. 2020). We observed that in our case studies, leadership is a key factor for self-organization. In one of the best organized communities, the leader's ability to organize committees, bring residents together and participate greatly facilitates water distribution. In the other community, the lack of participation is due to the various leaders who claim to be the representatives of the community. However, one thing we must not forget is that this leadership works best when there is a personal relationship with the authorities; the sustained and consistent interaction between leaders and government officials facilitates access to the water trucks and keeps the water trucks system functioning. Empathy, recognition and reputation within the community are also key.

### 6.3 COLLECTIVE AGENCY REDUCES THE RISK OF CRITICAL WATER SHORTAGES

Despite some persistent and emerging challenges in informal urbanization, most studies have reported at least partial "success" in improving access to water when people are self-organized and work together (Streule et al. 2020; Bisung et al. 2014). Additionally, collective agency in access to urban public services can make residents see themselves

as citizens rather than consumers. When there is greater collective agency, days without water are reduced, water sharing improves, and there is less purchase of private water. As a result, collective agency not only involves the ability to meet or achieve common objectives and goals, it can also help improve social welfare through empathy, generosity and commitment to others in the development of the community.

In general, the concept of informal urbanization focuses on the actions of people involved in the construction and maintenance of their own houses and their neighborhoods (Streule 2020; Correa et al. 2018). In this sense, self-organization makes a difference between a community facing, or not, enduring water scarcity. This strong collective agency reflected in self-organization and collective action permits the informal water distribution system to work, for example, when residents organize to search for water in the face of service failures, when they coordinate collective mobilizations for water, and when they spend time waiting for water trucks.

## 7. CONCLUSIONS

Collective agency, and its potential manifestation of collective action, has been incorporated into formal power and governance structures because residents assume responsibility for meeting their basic water needs. This situation generates conditions of vulnerability and risk for residents of informal areas because it limits the legitimacy of their demands for water and at the same time gives strength to the discourse of informality resulting in the legitimacy of non-compliance by the authorities. The authorities have perpetuated a neoliberal rationality in their approach to water delivery. This means that they justify the idea that residents in informal areas should pay a higher price for their water. At the same time, this rationality works as long as residents also internalize it and paying higher prices becomes a matter of fact. The normalization of informality creates poverty traps (Eakin et al. 2016), and governance gaps (Lerner et al. 2018) that could be overcome if collective agency and participation in decision-making over urban resources was formally acknowledged.

The explicit acknowledgement of the role of collective agency by governments may involve economic incentives and forms of compensation for, and institutional recognition of leaders, as well as communication tools to build stronger relationships. The communication between leaders and authorities could be made more transparent and efficient, for instance by creating a phone app through which community members would monitor trucks and

leaders would directly communicate with government agents without needing to travel to Municipal offices. These incentives, compensations, and communication tools could facilitate the building of collective agency in both studied communities, but empathy, trust, reputation and personal forms of recognition might still be helpful and perhaps necessary. In this regard, the Municipality could offer capacity building and training approaches to promote the emergence of stronger leaders (Ferrero et al. 2019).

The formal sector must deal with an informality that will persist, some of which, like the examples in this study, work better than others. Therefore, understanding the factors that allow it to function and allow people to have water at a low cost would allow for guaranteeing the human right to water, for example, trust, motivation to demand services, common goals, leadership, are some of the elements that are involved in what we call collective agency and action. Also, self-organization created new agreements to reduce water scarcity and enhance well-being. In the face of water crises, collective agency represents an opportunity for water management in peri-urban areas, because it can enable a more efficient distribution and access in communities living under an irregular water distribution system.


## NOTES

- 1 In 2012, in Article 4 of the Mexican Constitution, water was recognized as a human right (Diario Oficial de la Nación, 8 de febrero de 2012).
- 2 The Sustainable Hydrological Law of Mexico City declared that it is prohibited to provide water in informal settlements located outside of urban areas (SACMEX (2017). Proyecto Final de Ley de Agua y Sustentabilidad Hídrica. Sistema de Aguas de la Ciudad de México).
- 3 The Movimiento Urbano Popular was a social organization that worked together to enhance better conditions of housing during 1960 until 1980 in Mexico City (Bennett & Bracho 1993).
- 4 The *tandeo* system is a water supply system that provides the population with water on a specific schedule, for example, hours per day or days per week. In the case of informal settlements, water is provided to them once or twice a week exclusively by water trucks (Aguilar & Santos 2011).
- 5 The Conservation Zone (CZ – *Suelo de Conservación*) is a delineated protected area of Mexico City that provides environmental services to maintain the quality of life of the inhabitants of Mexico City, such as the recharging of the aquifer, in accordance with the Environmental Law of the Federal District (Ley Ambiental del Distrito Federal 1996).
- 6 *Paradas* are the places designated by the authorities to fill the water storage (*tambos*) through the public water trucks. These are generally located outdoors and under unsanitary conditions so that the water received by homes at these points is usually not used for human consumption. The literal translation to English is “stops”, but in this paper we translated it to “delivery sites”.
- 7 *Folios* are a log to record water received by a household. The folio is a way of formalizing informal access to water. It was implemented by the municipal government to reduce informal growth by limiting the quantity of water deliveries permitted in these areas.
- 8 According to the interviews, the folio was initiated many years ago by the local government after the communities mobilized for water access.


## COMPETING INTERESTS

The authors have no competing interests to declare.

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