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Sustainability of Water Systems in Tacaná, San Marcos built over the last 25 years

Background

CARE Guatemala has worked in water and sanitation in Tacaná for over 10 years. CARE has helped construct potable water systems, trained community members to manage the systems, improved sanitation in schools, and led sanitation workshops for students. Most recently, CARE was involved in the Lazos de Agua (Water Links) project, which was completed in October 2016, in the municipalities of Tacaná and Tajumulco. One of the project's main goals was to increase access to sustainable, safe water for at least 5,000 people[1]. In addition to providing access to clean water, it is imperative to ensure the sustainability of improved water systems into the future. In order to monitor the functioning of the water systems, the Municipal Water and Sanitation office (OMAS) was created in Tacaná in 2012. The OMAS is responsible for the operation, management and maintenance of the water systems in both urban and rural areas of Tacaná. However, neither the OMAS nor CARE have had adequate resources to consistently monitor the water systems that have been built over the last 25 years. The purpose of this study was to evaluate the functionality and sustainability of the water systems constructed by CARE and other organizations over the past 25 years in Tacaná.

Methods

We created two surveys to assess the functionality and sustainability of the water systems. One survey was for the local water committee or *comisión de agua y saneamiento* (CAS) and included questions about the functionality, maintenance, and management of the water system. The other survey was directed towards the users of the water system and was administered to five households in each community. This survey included questions about the functionality of the water system in the home, tariff payments, interactions with the water committee, and the impact of the water system in daily life. The water committees were contacted at least one day prior to the community visit. The research team requested that members of the water committee be present to respond to the survey. The households were selected by convenience sampling, as the members of the water committee had to escort the two enumerators to houses nearby the town center. In many cases, it was not feasible to visit houses from varying distances from the town center, which might have provided more varied responses. Data were collected from 20 communities in the municipality of Tacaná, San Marcos over the period June 13-July 18, 2017.

A functionality score was created to assess the functionality of the water systems using multiple indicators. Details on the six specific variables to create the score are included in Table 1. The score ranges from zero (non-functional) to nine (highly functional).

Table 1: Description of variables used to create the functionality score

Variables	Values and contribution to score
Quality of construction (evaluated by the OMAS)	2. Good 1. Regular 0. Poor
Drainage (evaluated by the OMAS)	2. Good 1. Moderate 0. Poor
Number of times the system has not worked in the last 6 months	2. 0 times 1. 1-2 times 0. 3+ times

Complete bacteriological analyses	1. Yes 0. No
Complete physicochemical analyses	1. Yes 0. No
Functioning in 100% of the households	1. Yes 0. No

Results

General

Twenty water systems were analyzed in twenty communities in Tacaná, San Marcos. The water systems ranged in age from one to 23 years old, with a median age of four years old. All the systems were gravity-fed systems that used spring water. Sixty percent of the systems were newly constructed, 30% were reconstructed and 10% were rehabilitated systems. Appendix A shows the basic information of the water systems from each community. CARE supported the construction of 12 of the water systems. Appendix B includes a table that describes the differences between the water systems constructed by CARE versus other organizations.

Functionality

All of the systems had water on the day of the visit; however, the functionality of the systems varied. The majority (90%) of systems were completely functional at the time of visit, while two (10%) were functional but needed repairs. Additionally, two communities had experienced three months or more without water to any households. In 80% of the communities, the water system functioned in all of the houses. It was no surprise that the only variable we found significant at 0.05 for functionality, was age of system (Table 2.1). The average functionality score for the systems constructed by CARE (not shown) was 6.8, at 95% Confidence Interval (CI) (6.1, 7.7) which was higher than the average score of those constructed by other organizations: 5.6 (95% CI: 3.6, 7.6). Furthermore, those communities with the recommended tariff amount of 12 quetzals per month had higher functionality scores than those with a lower tariff [7.20, 95% CI (5.58, 8.82) vs. 6.07, 95% CI (5.03, 7.10) respectively]. Lastly, in communities where all households pay the tariff, the functionality score of the water system was higher than those in which not all users pay the tariff [7.22, 95% CI (5.84, 8.60) vs. 5.60 (4.47, 6.73)]. Appendix A lists the functionality score of each water system.

Table 2.1: Functionality Scores according to various variables

Variable	Values	Mean functionality score (95% CI)	p-value
Age of System	New (Built within the last 5 years)	7.11 (6.06, 8.16)	0.02
	Old (Built over 5 years ago)	5.73 (4.45, 7.01)	
Tariff amount	Recommended (12Q per month)	7.20 (5.58, 8.82)	0.23
	Less than recommended	6.07 (5.03, 7.10)	
Payment of tariffs	100% of households pay*	7.22 (5.84, 8.60)	0.05
	Less than 100% of households pay*	5.60 (4.47, 6.73)	
Contracting of the plumbers	Permanent	6.8 (5.18, 8.42)	0.51
	As needed	6.14 (4.99, 7.29)	
Women on the CAS	Women present	6.00 (4.33, 7.67)	0.49

	No women present	6.58 (5.52, 7.65)	
Who Founded the CAS	Community Members	6.5 (4.9, 8.1)	0.83
	Organization outside of the community	6.3 (4.9, 7.7)	
Frequency of CAS meetings	Regular meetings	6.5 (5.6, 7.3)	0.63
	When there is a problem only	6.0 (2.8, 9.2)	
Organization who constructed system	CARE	6.8 (6.1, 7.7)	0.19
	Other organization(s)	5.6 (3.6, 7.6)	
Members of the CAS knowledge of how to do large repairs to the system	Yes	6.4 (5.1, 7.8)	0.84
	No	6.3 (5.0, 7.5)	

*based on CAS determination

Table 2.2 Water Systems constructed by CARE versus other organizations

Variable	CARE (n=12)	All (n=20)
System functions in all households throughout the year	10 (83%)	16 (80%)
All houses have water service 24 hours per day	11 (92%)	18 (90%)
Completely functional the day of the visit	10 (83%)	18 (90%)
Measure water level at the sources	11 (91.7%)	14 (70%)
Record of the water level at the sources	6 (50%)	7 (35%)
Water committee members can make minor repairs to the system	12 (100%)	20 (100%)
Water committee members can make major repairs to the system	7 (58%)	9 (45%)
Adequate tariff (12Q by month)	5 (41.7%)	5 (25%)
The tariff is sufficient to cover the functioning of the system according to the CAS	9 (75%)	14 (70%)
The tariff is sufficient to cover the major repairs to the system according to the CAS	4 (33%)	4 (20%)
Has women present on the CAS	4 (33%)	8 (40%)
The CAS stores the collected tax in a bank account	1 (8%)	4 (20%)
The CAS holds meetings on a regular basis	8 (67%)	15 (75%)
The CAS has meetings on a regular basis with the community	7 (58%)	14 (70%)

Maintenance

At the time of the visit, 75% of the water committees reported chlorinating their water distribution tanks. The OMAS recommends water committees to chlorinate their water systems every 15 days, but only 20% of the CAS chlorinate their water every 15 days. Eleven communities (55%) chlorinate the water system at least once a month and the rest of the communities chlorinate the water systems even less frequently. Without chlorine to disinfect the water distribution systems, there is an increased risk of contamination of the water supply. A master's student from Tufts University (Anna Grammerstorf) tested the water quality of the water systems using the Aquagenx Compartment bag test[2]. Seven (23%) of the 30 tanks and water taps that were tested were positive for *E. coli*. *E. coli* is an indicator for fecal contamination in water[3]. The various levels of contamination in the community water tanks or faucets is shown in Table 3.

Table 3: Contamination in seven water systems in Tacaná

Community	Source	Risk	Frequency of chlorination
Sanajaba	Faucet	Intermediate/probably safe	Every 3 months
Cantón Chemealon	Faucet	High risk/ probably unsafe	Every 2 months
Plan Chiquito	Faucet	High risk/ possibly unsafe	Every month
Tonola	Faucet	Intermediate/probably safe	Every month
Tuichapse	Faucet with a filter	Intermediate/probably safe	Every 2- 3 months
Chiquilau	Tank	High risk/ probably unsafe	Just started chlorinating
Tuipic	Tank	Intermediate/probably safe	Just started chlorinating

Most of the communities (85%) have needed a repair to their water system at some point. In 88% of the communities, their own water committee completed the last repair; in the remaining communities, an NGO completed the last repair. All of the water committees cleaned their water tanks at least once every four months. Figure 1 depicts the frequency with which the water committees clean their tanks.

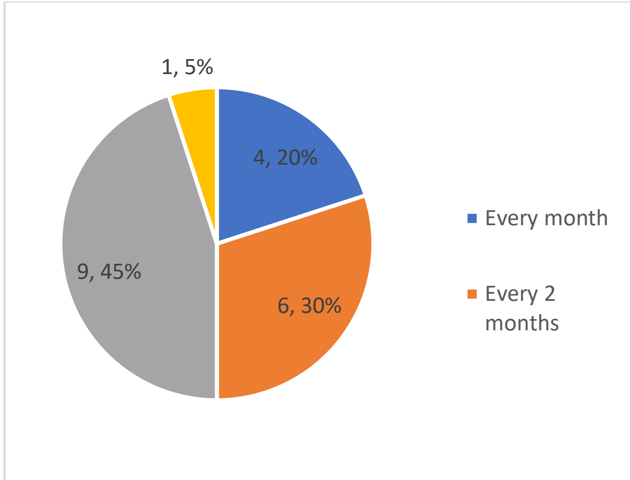


Figure 1: Frequency with which the water committees clean their water tanks.

Additionally, 90% of the water committees knew whom to contact if they needed help with a major repair to their water system. Most of the communities said that they would contact the OMAS, and two communities said that they would contact CARE.

Financial Management frequency

Every water committee said that they have a tariff for the water service in their community. However, in half of the communities, at least one person said that they did not pay the same amount as the CAS-defined tariff. In one community (Las Tablas), everyone interviewed said that they pay twice as much as the CAS-defined tariff. Since it is unlikely that the people are paying more than required, they might not actually be paying anything for the water or they might have overestimated how much they pay.

The tariffs range from two quetzals to 12 quetzals per month. CARE and the OMAS recommend a tariff of twelve quetzals per month for a sustainable water system, but only five communities have a tariff of 12 quetzals per month. The communities with the recommended tariff had a higher functionality score (7.20) than those with lower monthly payments (6.07). Additionally, all of the water committees have some savings from the tariff. The median savings was 10,000 quetzals with a range of 1,000 to 200,000 quetzals. Although all committees have savings, only 20% of the water committees have a bank account in which they deposit their money.

Water System Users

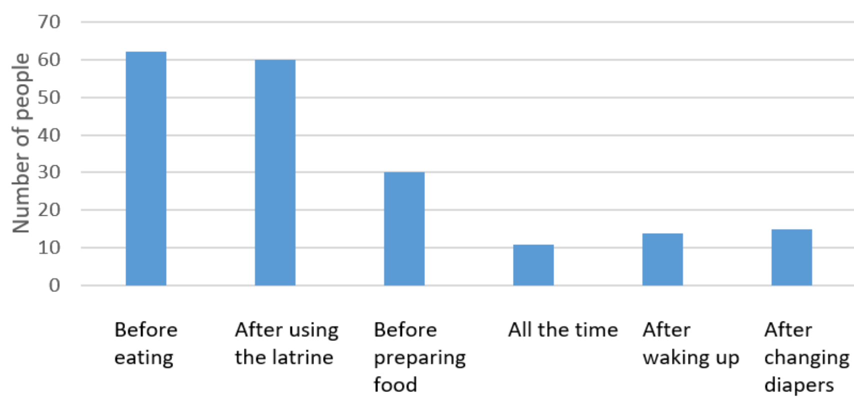
One hundred water system users were surveyed in total (five in each community). The majority (85%) of those interviewed were women. Ninety-three percent of those surveyed had water 24-hours per day when the system is functioning. Most users (71%) had experienced a lack of water at some point, with the majority experiencing just a few hours to a day without water as a result of the water committee repairing the system. The maximum number of days reported without water was two weeks. Because there are some times when the households were without water, many of the households (83%) stored water for drinking. Additionally, 98% of the users boil their water in the home to ensure it is safe to drink. However, contamination at the household level can occur even after boiling the water if it is stored in a dirty container. At the household level, we tested 25 containers of water that had been boiled. We found that, out of the 25 water samples tested, nine (36%) of the samples were contaminated with *E. coli*. Appendix C shows the levels of contamination found from the containers that tested positive for *E. coli*.

Watershed Protection
The majority (85%) of the water committees say that they participate in watershed protection activities. Additionally, 87% of the users interviewed or their family members participate in watershed protection activities and 79% of those who participate in these activities do so every one to three months. There is no statistically significant association between water system function in the summer and community participation in watershed protection activities (p-value: 0.52). This could be explained by the finding that 14 (70%) communities said that they participate in watershed protection, and of those, 78% noticed a lower amount of water in the system during the summer months. All six communities that do not participate in watershed protection noticed a lower amount of water in the summer.

User knowledge and Involvement with the water system
All of the water committees held meetings with community members on a varying basis. Eighty-six percent of the users interviewed said that the water committee notifies them of the costs that they are spending on the system. Also, 97% of the water system users interviewed said that they or a family member attend the water committee meetings when they are open to the community.

Impact
Eighty-four percent of the water system users surveyed said that the health of their family has improved since the installation of their water system. In addition, 82% of those surveyed said that the health of their community as a whole has improved since the water system was constructed. Personal hygiene improved: 85% of those surveyed said that the hygiene practices of their family have improved since the water system was installed. We also asked them to state when they wash their hands throughout the day and the responses of the 100 community members surveyed are depicted in Figure 2 (multiple answers allowed).

Figure 2: Number of people who said they wash their hands at key moments during the day.



Limitations

Not all members of the water committee were present at each community to respond to the survey. Therefore, it is possible that the survey did not fully capture all of the organizational knowledge that may have been present had all of the water committee members been able to participate. Additionally, the households were not selected at random, so the households that participated in the surveys are not a representative sample of all of the households in each community.

Conclusions and Recommendations

All of the communities that we visited had functioning water systems at the time of the visit. All of the communities had plumbers within their communities that they could count on to fix the system if it needed minor repairs. Ninety percent of the communities knew who to contact if they needed help with a major repair to their water system. Additionally, all of the communities reported collecting a tax for their water service.

<u>Recommendation 1</u>: The water committees should emphasize, to all households, the importance of paying the tariff for the service.

Not all of the homes in each community pay the same amount for the tax and many homes pay less than the CAS-defined tariff. Additionally, perhaps CARE should complete a sensitization activity or workshop with communities with very low tariffs to encourage them to increase the tariff to help care for the system into the future. This could include bringing select members of a water committee from another nearby community that collects a sufficient tariff to talk about how they implemented collecting the tariff and the benefits of having the tariff at the higher amount.

<u>Recommendation 2</u>: In general, better management of tariff funds is needed.

Although all communities collect a tax, the majority of the communities do not deposit their money into a bank account. Wherever possible, bank accounts could generate interest from community funds. Wherever bank accounts are not a feasible or desirable option, savings should be managed by the treasurer and accurate records should be taken of the incoming funds and expenses. The president of the water committee should also be aware of where the funds are being stored and the financial situation of the water committee. If the water committee has access to a laptop, a computer program called the Comprehensive Water Management System (SIGA) would be beneficial to manage the finances of the water committee.

<u>Recommendation 3</u>: All communities should prepare for a scarcity of water in the summer.

The majority of communities noticed a reduction in water quantity during the summer. All communities should prepare for this. One way to try to prevent water shortages is to participate in reforestation activities every few months throughout the year. Also, the communities could increase the diversity of their water sources, if possible. Furthermore, community members should be encouraged to conserve water, especially during the summer months. One way to conserve water would be to re-purpose greywater for gardening or toilet or latrine cleaning.

<u>Recommendation 4</u>: It is also imperative for many of the communities to chlorinate their water systems more often (every 15 days) in order to prevent contamination in their water systems.

Many of the water distribution tanks and household water storage units were contaminated with *E. coli*. The water committees should test the water for chlorine and chlorinate the water distribution systems more frequently in order to prevent contamination. Furthermore, even if the water distribution systems are distributing clean water, the manipulation of the water at the household level may cause the water to be contaminated. CARE should use community mobilization[4] in order to show the community the contamination that is present in the household water storage units and discuss with the community members what they think would work best to clean the storage units and keep them clean.

References

1. CARE (2016). Lazos de Agua. Retrieved from: http://www.care.org.gt/index.php/29-\programas/seguridad-alimentaria-nutricional-y-medios-de-vida/lazos-de-agua
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Appendix A.

Table of basic information of the water systems from all communities surveyed

Community	Age of System	Institutions that supported construction	Number of communities the project covers	Number of water sources used	Number of taps	Functionality on day of visit	Functionality Score
El Carmen, Sujchay	3	Municipality, Helvetas	1	1	18	Completely functional	9
Sujchay	23	PAISA, CARITAS	4	3	350	Completely functional	7
Sanajaba	8	CARE, UICN, municipality	5	2	385	Functional, but needs repairs	7
Aldea Cunlaj	10	FIS	1	1	124	Completely functional	8
Salinas, Ojo de agua e Ixmugil	1	CARE, municipality, community	3	3	166	Completely functional	6
12 de Mayo	3	CARE	1	3	105	Completely functional	8
Cucuna	2	CARE, municipality	1	3	63	Completely functional	7
Tojpac Nuevo Horizonte	1	CARE, municipality, community	1	1	107	Completely functional	6
Tonala	4	CARE, municipality, community	1	5	103	Completely functional	7
Los Ceresos	1	Municipality	1	1	45	Completely functional	5
Chemealon	2	CARE, FEMSA, Municipality	1	14	120	Completely functional	9
Las Tablas	17	Agua del pueblo	1	2	120	Completely functional	3
Sector Plan Chiquito	1	CARE, Helvetas	1	1	36	Completely functional	7
Tonichincalaj	7	CARE, UICN, municipality	1	16	164	Functional, but needs repairs	6
Tuichapse	8	CARE, municipality, UICN, Caritas, Diosesana	1	8	140	Completely functional	8
Suitquin	8	CARE, UICN, CRS	1	8	125	Completely functional	5
San Pablo, Sector 5	10	Caritas, Diocesana, Helvetas	1	4	45	Completely functional	2

Pin Pin	17	Fis	1	Unk.	Unk.	Completely functional	5
Chiquilau	19	PAISA	2	1	103	Completely functional	6
Tuipic	18	CARE	1	2	78	Completely functional	6

Appendix B.

Water Systems constructed by CARE versus other organizations

Variable	**CARE (n=12)**	**All (n=20)**
System functions in all households throughout the year	10 (83%)	16 (80%)
All houses have water service 24 hours per day	11 (92%)	18 (90%)
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The CAS stores the collected tax in a bank account	1 (8%)	4 (20%)
The CAS holds meetings on a regular basis	8 (67%)	15 (75%)
The CAS has meetings on a regular basis with the community	7 (58%)	14 (70%)

Appendix C.

Contamination levels among contaminated containers storing boiled water

Community	Source	E. coli MPN/100mL	Risk
Ojo de Agua	Container of boiled water	48.3	High risk/ probably unsafe
Canton Cucuna	Container of boiled water	>100	Unsafe
12 de Mayo	Container of boiled water	32.6	High risk/ probably unsafe
Tonola	Container of boiled water	1.2	Intermediate/probably safe
Tonola	Container of boiled water	1.5	Intermediate/probably safe
Las Tablas	Container of boiled water	1.5	Intermediate/probably safe
Plan Chiquito	Container of boiled water	4.7	Intermediate/possibly safe
Tuichapse	Container of boiled water	3.9	Intermediate/possibly safe
Chiquilau	Container of boiled water	48.3	High risk/ probably unsafe