

Individual perceptions and the performance of community based drinking water organizations

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Abstract:

This paper presents an analysis of the underlying factors affecting the satisfaction of people with drinking-water quality provided by community-based organizations in rural areas of Costa Rica. These organizations provide water to more than 60 percent of the total rural population. There is, however, a great disparity in their performance, in particular regarding to the quality of water provided. Using an ordered probit regression and data from 41 villages, we studied how characteristics of the infrastructure, the governance structure and the attributes of local people affect the perception of water consumers with water quality at home. We found that size and age of the infrastructure; accountability mechanisms and public disclosure of information; demand responsiveness; as well as the human capital of the members of the local water committee; are the main predictors of the capacity of local organizations to satisfy the needs of consumers in terms of water quality.

Key words: *local institutions; common-pool resources; SES framework, water quality*

1. INTRODUCTION

Water policies in many countries do not promote the creation of appropriate institutions for managing water needs and, enhancing supply augmentation and management capabilities (Saleth and Dinar 2004). Most rural areas of the

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developing world, drinking water coverage from an improved source and sanitation services remain unacceptably low (WHO and UNICEF 2006). Costa Rica has one of the highest coverage ratios for drinking water in rural areas in Latin America (WHO and UNICEF 2008); however, this not necessarily implies that water provided can be safe for human consumption. In fact, only 60% of water provided meets the national standards for water potability (LNA 2008).

Even that performance is a multidimensional concept; our aim to focus on water quality tackles one of the principal factors that have a decisive impact on individual welfare and has a clear relevance for the Costa Rican context as well of that of other nations. The public awareness over drinking water quality has risen due to environmental pollution and episodes of waterborne diseases worldwide (Anadu and Harding 2000; Turgeon et al. 2004). Having that the characteristics of tap water (aesthetics or bacteriological and chemical content) are mediated by the actions taken by local providers and the water infrastructure available, the main objective of this paper is to identify those physical and institutional factors that affect the capacity of local providers to satisfy the needs of consumers regarding the quality of tap water.

The provision of drinking water by community-based organizations (CBDWO) in rural areas is widespread in Costa Rica, in contrast to the prevalence of governmental water utilities in urban areas. Even though, the central government has historically subsidized the rural sector and has the legal mandate to oversight these organizations. The few studies that analyze the performance of CBDWO in rural Costa Rica (Madrigal et al. 2010; ICAA et al. 2002) suggest a high variability in their performance, leaving in some cases consumers exposed to water shortages and particularly, to poor water quality. It has been noted that the explanation of these differences might be attributed to differences in downward accountability mechanisms, the existence of a demand driven approach, and the human capital of the local water committee, among other factors (Madrigal et al. 2010).

From a theoretical point of view, the problems of provision of safe drinking water in rural areas can be addressed using the vast literature related to collective action in common pool resources. However, this literature is mostly built around single case studies and meta-analysis thereof. The efforts to compare case studies to obtain more general conclusions have been hindered by sample selection problems in the

construction of comparative databases, disciplinary differences, missing variables, differences in conceptualization and empirical measurement of variables (Poteete and Ostrom 2008; Agrawal 2001). This paper tries to bridge this gap by means of a comparison of 41 cases of CDBWO that differ in the achievement of performance goals and presumably, in the way they solve effectively their collective action problems.

This paper is organized as follows. The next section describes the general characteristics of drinking water sector in rural areas of Costa Rica. Section 3 discusses the principal results of the literature of determinants of performance in CDBWO. Section 4 presents the research design, including sample selection strategy and data collection protocols. The last two sections present results and conclusions, respectively.

2. DESCRIPTION OF WATER SECTOR IN COSTA RICA

Since decades ago, the Costa Rican government has assumed a direct role in the provision of basic services to the population, including drinking water by domestic connections. The ICAA (Instituto Costarricense de Acueductos y Alcantarillados, by its spanish acronym) is an entity constituted in 1961 by the central government with the dual purpose to oversight drinking water use throughout the country, and to be responsible for the design, construction and, management of infrastructure to provide drinking water to urban and rural communities (ICAA 2007). From the 1960's to the 1990's, the central government invested large sums of money, either by directly constructing and administering new infrastructure as well as giving subsidies to CDBWO to invest in their own systems. Nowadays, some of the water systems previously operated by the central government or municipalities are administered by CBDWO.

In rural areas, the main suppliers of drinking water are two different types of CBDWO: CAAR (Comités Administradores de Acueductos Rurales, by its spanish acronym) and ASADAS (Asociaciones Administradoras de Sistemas de Acueductos y Alcantarillados Sanitarios, by its spanish acronym). There are more than one thousand CAAR and ASADAS, responsible for the provision of water to nearly one million people throughout the country. Table 1 presents some of the main characteristics of these organizations.

Table 1. General features of CBDWO in rural areas		
	CAAR	ASADAS
Number of organizations	434	658
Communities average size (# of households)	195	237
St.dev. from media	255	290
Communities median size (# of households)	102	130
% that provide potable water*	51	58
% of gravity fed systems	47	51

* Based on microbiological criteria

Source: Own calculations based on ICAA 2008, LNA 2008

The main difference between both types of organizations is that ASADAS have a formal delegation agreement with ICAA. The delegation agreement implies the transfer of authority for public functions to local organizations outside the central government but ultimately, these organizations are formally accountable to the central government. In recent years, the ICAA is actively promoting the transformation of CAAR into ASADAS with the objective to change their legal status. Ultimately, the aim of ICAA is that this transformation will increase its capacity to oversight and control these organizations. However, an innovative way in which ICAA is trying to control and support the sector is through a voluntary adhesion program that gives an award to those organizations that comply with different technical standards that positively affect water quality. These standards are monitored periodically and have the objective to serve as a mechanism of public disclosure of information about water quality. The recipient organizations of this “Water Quality Seal”, receive a written recognition and an official white flag from ICAA, both placed by the awardee organization in a visible public spot. In case of non-compliance with standards, the organizations must remove the flag.

All CBDWO are administered by a committee appointed by adult local villagers, with no quotas based on gender, castes or other social distinction.⁴ Members of these committees do not receive any payment and there is minimal direct intervention of the central government in the decisions taken by them. Even that central government imposes certain rules; there is an important lack of enforcement in most cases. For example, even that government sets the monthly water fee that must be locally charged, most CBDWO deviates from that. More than 90% of people in rural areas

⁴ There is no evidence that these mechanisms exclude certain groups. However, voting is restricted to one person per household, usually adult men.

have tap water in their houses (with an average consumption of 20 cubic meters per household). However, only 60% of that people receive water that is considered potable (LNA 2008). In contrast, more than 98% of urban households have tap water that meets the national standards for water potability. The importance of gravity fed systems in rural areas entails an important challenge to improve the quality of water because the vulnerability of these systems to different sources of contamination tend to be relatively high.

3. LITERATURE REVIEW

Performance evaluation implies the verification of achievement of certain objectives⁵. Even that performance might be analyzed as a multidimensional concept, there is no scholarly agreement regarding what objectives pursued by CBDWO must be considered as performance yardsticks as well as the methods to measure them (Prokopy 2005; Madrigal et al. 2010). One possibility in this regard is to measure performance by means of the direct assessment of consumer satisfaction with different aspects of the water service, such as tap water quality.

Some literature (Doria 2010; Fife-Schaw et al. 2007) that analyze the satisfaction of consumers with water quality suggests that the individual perception of water quality is mostly influenced by organoleptics (i.e. characteristics of water perceived by senses), in particular flavour. The reasons of why people (most in urban areas of developed countries) state such importance to something purely aesthetical are not clear yet; however, it is suggested that the public may relate organoleptics to health risks⁶ and also considered water is a product that should be enjoyed, rather than a basic necessity (Doria 2010). However, individual judgments based on sensory perceptions, may or may not be related to the real bacteriological or chemical characteristics of water (Fife-Schaw et al. 2007). Furthermore, given that the aesthetic quality of drinking water is usually the only consideration in judging water quality, in some cases consumers will link an aesthetic problem (an unpleasant flavour, odor or color) to a potential health risk (Jardine et al., 1999). Finally, Even though this literature also devotes attention on how demographic variables of people

⁵ The process of benchmarking and performance evaluation of water utilities in urban areas of Latin America has been extensively developed in recent years (Corton 2003; Berg and Corton 2007). However, given the relevance of rural water community organizations in the region, there is a lack of studies that tries to measure performance in this sector.

⁶ Anadu and Harding (2000) define risk perception as an individual's subjective judgment based on aesthetic and non-aesthetic qualities.

(age, gender, education, among others) affect their perception of water quality, there are ambiguous results in terms of their significance and direction of this effect (Doria 2010).

As an alternative contribution to the above findings, this paper uses an institutional analysis approach to identify the exogenous factors that might be affecting the capacity of CBDWO to satisfy the needs of local consumers in relation to water quality. In other words, instead of establishing which physical characteristics of water affect the satisfaction of people, our aim is to identify in which contexts people tend to be more satisfied. In particular, we want to establish what attributes of CBDWO and the water infrastructure are correlated with the individual perception of water quality.

The ontological framework developed by Ostrom (2007), and adapted by Madrigal et.al. (2010) for the case of CBDWO, is used as a general guide to identify the main variables that might be affecting outcomes in these settings. Broadly speaking, this framework analyzes how characteristics of the resource system and the units derived from it; the attributes of users and the governance structure jointly affect outcomes. Even that each of these components include a large number of variables identify as relevant by different scholars in the tradition of common-pool resources, not all these variables need to be measured and analyzed it, only those that are considered relevant for the outcome to be explained.

Quite obviously, besides conditions that naturally affect the hydrological cycles and land use, the characteristics of the infrastructure and technology are important contextual factors that might affect the capacity of CBDWO to provide water that meets the requirements of consumers. The age of the infrastructure seems to be a crucial factor influencing water quality, especially in non-chlorinated systems. It is well known that break failure probability is a function of time (Andreou et al. 1987), increasing the likelihood that older systems can be easily contaminated by sediments, animal disposals and human activities in general. Even that microbiological contamination can be controlled by the chlorination of water, the use of chlorine is sometimes mentioned as a cause of objectionable tastes leading to consumer complaints (Piriou, et al, 2004; Doria 2010).

The size of infrastructure has a powerful impact on maintenance tasks such as repairing pipe breaks and blockages; diagnostic of problems and technological complexity (Kleemeier 2000). The size of infrastructure is also positively correlated to the number of people in the community. Earlier theoretical works (Olson 1971) suggested that the possibilities to reach agreements in larger groups are low due to the transaction costs and free-riding problems. However, some authors argued that the effect of size depends on contextual factors, such as social norms and socioeconomic heterogeneities (Poteete and Ostrom 2004; Agrawal 2001).

Regarding the attributes of the governance structure of CBDWO, one of the main findings in the literature is that a demand driven approach positively affects performance or sustainability (Isham and Kähkönen 2002; Sara and Katz 1998; Watson et al. 1997; Prokopy 2005; Prokopy et al. 2008; Madrigal et al. 2010). This approach generally includes i. incentives for communities to initiate action because the salience or the necessity to overcome a situation in which the existence of good water provision is threatened, ii. community participation on the design of infrastructure and institutions, iii. cost recovery practices or willingness to pay for investments and maintenance activities. The presence of a demand driven approach might reveal information about the priority of water investments within the portfolio of development projects in the community and in addition, it might create a sense of ownership because the decisions of the community are supported by their own resources.

The promotion of CBDWO could be considered within policy trends that aims the development of decentralized institutional arrangements for water management. Even that such processes have limited success as panaceas (Meinzen-Dick 2007), a key feature that has been associated with an effective decentralization of natural resources in general is the ability of local authorities to be downwardly accountable (Ribbot et.al 2006). Typically, elections are seen as the mechanism that ensures accountability from leaders or decision makers to the local population (Ribbot et.al 2006).

However, the notion of downward accountability is much broader that includes other means, such as public audited reports, general assemblies and other informal mechanisms. In addition, accountability mechanisms should include information sharing across different governmental entities and population, and civic education of

local peoples and authorities so that people “know what they can demand—what they can hold local authorities accountable for—and so local authorities know what they can offer” (Ribot, 2004 cited by Ribbot et.al 2006). In the literature of CBDWOs, downward accountability mechanisms, as opposed to accountability to the central government, have been found as key drivers of performance (Madrigal et al. 2010). Downward accountability is intrinsically linked to the provision of information to consumers and the resolution of their complaints or enquires. In this regard, different authors (Fife-Schaw et al. 2007; Doria 2010; Owen at al. 1999) argue that the incapacity of providers to timely attend this type of consumer demands can generate doubts in the consumers about the trustworthiness of the supplier and the water provided, even in cases where water meet technical standards of safety.

The “Water Quality Seal” program developed by ICAA could be an effective way for promoting the adoption of certain standards for water quality, providing information to consumers as well and becoming an alternative way of making committee members accountable to local consumers and to ICAA.⁷ Information disclosure about drinking water quality has been used as instrument to increase the knowledge of consumers about tap water and to promote the compliance of utilities with certain standards (Bennear and Olmstead 2008). Information disclosure on water quality can also influence the confidence of consumers (Fife-Schaw et al. 2007) and may lead to changes in knowledge and emotions that change the how risks are perceived (Doria 2010).

There are important attributes from local users that might also influence the performance of CBDWO. The human capital within a community (native intelligence, skills, abilities, education, and health of individuals) has been considered one of the pillars for successful community based water management (Flora 2004). In particular, the effect of human capital of the water organization on performance has been empirically studied by Propoky et al (2008), using as proxy the length of time served by committee members and operators in their respective roles. Their findings suggest that experience positively affects the physical performance of these systems.

⁷ We are not analyzing the decision to participate in this program, neither the effectiveness of the program as a whole. The empirical evidence suggests that voluntary environmental regulatory programs in general are sometimes ineffective. Already-clean firms have clear incentives to join voluntarily because minimal investments are required to meet the standards, while significant benefits are expected in terms of positive publicity, subsidies, and regulatory relief (Blackman et al. 2010).

In addition, the membership of women on water committees has been analyzed in the context of CBDWO and indicates that gender-balanced committees and, more importantly, communities in which women have real potential to affect decision-making processes are associated with better performance (van Wijk-Sijbesma 1998; van Wijk-Sijbesma 2001; Madrigal et al. 2010; see also Propoky 2004 for less clear-cut results), while also providing empowerment and economic retributions for women (Verhagen et al., 2004; van Wijk-Sijbesma, 2001). The critical mass of women within local organizations or “threshold representation” has been analyzed in different settings, a threshold of one third is generally accepted (van Wijk-Sijbesma 2010; Agarwal 2010).

The importance of social capital, understood as the group of norms and networks that facilitates collective action,⁸ is well documented in the literature as relevant factor that affect the capacity of local communities to self organize and endure over time (Ostrom 2007; Grootaert 1998; Putnam 1993). In the case of drinking water, the empirical evidence indicates that the existence of other, non-water related, networks and associations in a community helps to solve collective action problems like the ones involved in the design, construction and operation and maintenance of drinking water systems (Isham and Kähkönen 2002; Kähkönen 1999).

4. METHODS

Sample selection

Analyzed CBDWO were randomly selected from the Metropolitan and East Central Region. There are two reasons for selecting these regions, within a total of seven administrative regions of the country. The first is because their relative importance: Both regions together account for 36% of total population served by CBDWO in Costa Rica and 30% of all CBDWO that exist are located here. Second, both regions are relative similar in terms of precipitation, temperature, geographic characteristics and feeder technology. This strategy reduces the number of confounding variables that might affect the performance of CBDWO.

⁸ That are different definitions of social capital and how it affects collective action, see for example Flora (2004); Putnam (1993); Grootaert (1998a).

From the population of 326 organizations that exists in both regions⁹, 41 were randomly selected for this study. Table 2 summarizes the principal characteristics of these organizations.

Table 2. General characteristics of CBDWO in the sample

Number of organizations	41
Organizations with delegation agreement	71%
Media of size (# houses in community)	286
Median of size (# houses in community)	160
Organizations with “Water Quality Seal”	10%
Organizations with volumetric pricing	46%
Gravity fed systems	100%

The coverage ratio (number of houses connected by the pipelines) is almost 100% in all communities; however, they do not necessarily receive potable water. All households pay a monthly fee for their water service and people do not have to spend time collecting water from other sources. Most people have access to basic services provided by the central government (education, health). Poverty levels are relatively low (population below the poverty line is 20% in Costa Rica) and no significant cultural differences exist. Therefore, the level of social and economic status is similar within and across communities.

Survey instrument design

Two different types of data gathering protocols were designed. First, a semi-structured interview was designed to gather information regarding different aspects of the local water organization. The main components of this interview were related to financial and legal aspects, human capital of water board, relationship with external actors (in particular ICAA), and accountability procedures, among the most important. This interview was conducted mainly with the president of the local organization. In all cases, the interview was made by the main author.

The other type of protocol was a survey mostly based on closed questions. This was conducted with the users of the water system in each community. For doing this, households were randomly selected all over the community.¹⁰ The head of the

⁹ Median size equals 136 households; average 266 households per community in both regions.

¹⁰ Differences in the geographical location of house might affect the quantity of water received and its quality. For instance, concentrations of the residual chlorine decrease as the water moves through the system and, in some cases may become very low and even undetectable at the extremities (Turgeon et al. 2004).

household (either man or woman) was interviewed. Households composed of close relatives of members of the water board were excluded in order to reduce untruthful answers. In most cases, 10%-15% of households in each community were surveyed, adding to 800 surveys in total.¹¹ This survey was made by three enumerators. They were trained intensively for about one week. The main components of this survey were related to satisfaction with tap water quality and quantity, participation in collective activities related to water provision, as well as individual socio economic characteristics, among others.

Analysis of data and measurement of perception of tap water quality

The results are analyzed using simple descriptive analysis as well as an ordered probit model to identify the effect of different explanatory variables on the individual evaluation of performance. Thus in this case, the dependent variable is based on the answers of individuals regarding satisfaction with water quality. The critical assumption for subjective measurement of satisfaction is that individuals are able to evaluate their satisfaction with water quality as a whole.¹²

The answers of consumers were framed into a Likert scale composed of four levels. The question was phrased as follows, “using a score from 1 to 4, in which 1 is being completely dissatisfied and 4 absolutely satisfied, how satisfied are you with tap water quality at home?. After the answer of the consumer, in all cases the enumerator made a follow up open question about the reasons to give that score. This helped us to evaluate the consistency of the numerical score assigned with a qualitative description of the general satisfaction of the consumer using verbal categories, such as completely dissatisfied; somewhat dissatisfied; satisfied; absolutely satisfied.

An analysis of perceptions is crucial to understand those aspects impossible to measure via external observation but central to decision making processes and performance of CBDWO. However it is important to recognize their limitations as

¹¹ Some characteristics of surveyed people can be found in the Appendix. We randomly interviewed adult men and women, especially during weekends. Weekend interviews maximized the possibility of having a more balanced sample in terms of gender (men usually work during weekdays).

¹² This is a common assumption in the literature that analyzes how characteristics of water affect the perception of people. However, approaches based on individual perception are becoming more common in other areas of research. For instance, recent literature has emphasized the use of subjective data to measure how satisfied (or happy) people are with their lives, their cities or their neighborhoods (Powell and Sanguinetti 2010; Di Tella et al. 2001). However, the correlation between economic and social indicators and subjective evaluation of satisfaction or happiness varies (Lora 2008).

well. The principal concern is that subjective measures might not be related to the bacteriological or chemical characteristics of water. Additionally, a rigorous technical assessment of water quality provided by CBDWO entails intensive monitoring of many organic and inorganic parameters over time as well as the analysis of the condition of the infrastructure and external threats that might affect the risk of contamination of water (LNA 2008). Even that these standards can be use a yardstick to compare the performance of CBDWO, in recent years is increasingly relevant the subjective assessment of water quality (Doria 2010; IWA, 2004).¹³ Furthermore, ignoring such the acceptability of people can lead to public discontentment and implementation problems (Doria 2010).

5. RESULTS

Descriptive analysis

This section presents a general description of characteristics of the local water organizations as well as different perceptions of water users. One important group of attributes that differ among organizations is related to water quality enhancing and conservation practices. Table 3 presents some of these characteristics. Only 29,27% of all organizations chlorinates water on a regular basis. This element coupled with the fact that all communities have superficial water sources leads to a vulnerable situation in terms of a potential bacteriological contamination of water. Furthermore, water quality analyses are not a regular practice. 45% of non chlorinated systems and 17% of chlorinated systems reported that water quality analyses are taken once in a while, with no periodical basis. This suggests that in these cases water committee members might have a lower level of training and understanding on the necessity to perform these analyses regularly. Finally, organizations also differ in terms of the periodicity of storage tanks cleaning. A lack of regular cleaning (at least one time per month) might entail another potential source of contamination, especially in non chlorinated systems.

¹³ In the literature of CBDWO, different authors have attempted to measure and explain the factors associated to different dimensions of the perception of people. Sara and Katz (1998) estimated an index of consumer satisfaction related to different components of the water service that also includes water quality; Prokopy (2005) analyzes consumer satisfaction regarding actual service; Prokopy et al (2008) analyses different dimensions of consumer satisfaction but not water quality directly. Madrigal et al. (2010) study the condition of infrastructure, the financial health of the organization and consumer satisfaction with water quality and availability.

Table 3. Water quality practices		
	Non-chlorinated systems	Chlorinated systems
Total	71%	29%
Water quality analysis		
Have performed water quality analysis in last 3 years	76%	100%
<i>Frequency of water quality analysis</i>		
Every 3 months	9%	42%
Irregular	45%	17%
Storage tank cleaning		
Have cleaned storage tanks in last year	100%	100%
<i>Frequency of storage tank cleaning</i>		
At least one time per month	70%	42%
Every 6 months	13%	42%

With respect to human capital, it is interesting to highlight some characteristics of the members of the water committee. On average, these water committees have 6 members; none of the members receives a salary and on average, 24% are women.¹⁴ Most of the committee members have been re-elected (4 years of average in actual position and 6 years in the organization), they lack of formal training in drinking water provision (less than half have attended any training course or seminar on water issues) and also lack of formal education (77% have primary education as maximum degree). This relatively low level of training and formal education does not necessarily entails a serious weakness for all water committees but in some cases it might reduce their capacity to deal with legal and financial aspects, to access different sources of funding and to realize the importance to enforce specific operational practices that secure water quality in particular.

Additionally to the above characteristics, it is important to study how the members of the committee are accountable to water users and the other actors. Table 4 presents some features of accountability mechanisms by type of organization, given that supposedly ASADAS must be formally accountable to ICAA.

¹⁴ In addition to the committee members, most CBDWO hire a part-time or full time paid plumber and in just few cases (15%), the organization hires a person to deal with administrative tasks.

Table 4. Accountability indicators by type of organization

	CAAR	ASADAS	Total
<i>Downward accountability</i>			
Deliver annual oral reports	92%	93%	93%
Deliver annual written reports	42%	55%	51%
<i>Upward accountability</i>			
Annual written reports sent to ICAA	17%	45%	37%
Have never sent reports to ICAA	75%	31%	44%
Receive visits from ICAA staff at least one time per year	17%	38%	32%
Have "Water Quality Seal"	-	14%	10%

In terms of downward accountability, almost all organizations deliver an oral report of activities and financial aspects in annual assemblies. However, only 51% give a written report of activities, results and future plans to the people who attend the assemblies; and in few cases, a brief communication note is attached to the monthly water bill. Every two years, all committee members are elected by those who attend the assemblies. The most striking difference between CAAR and ASADAS are related to upward accountability. It is very clear that ASADAS seem to be more accountable to ICAA compared to CAAR. However, the intensity of this relationship might be considered low compared to the aims of actual regulation and the delegation agreement signed by ASADAS that states, among other responsibilities, that all of them must deliver annual reports to ICAA.

This suggests that in average, the ICAA is incapable to enforce its obligation to supervise and support all CBDWO in rural areas (only 32% CBDWO report visits from ICAA personnel in last year) and to generate positive incentives to CBDWO to deliver reports (only 20% have received any feedback from reports). Further, there is no clear criteria by which some organizations receive more attention from ICAA. We later discussed that one possibility is that ICAA focus its efforts on monitoring those with relatively low performance. Finally, it is worth to mention that 14% of ASADAS are enrolled in the "Water Quality Seal". The participation in this voluntary certification program of information disclosure serves the dual purpose of organizations for being accountable to the central government as well to their local consumers.

Another group of attributes of the organizations is related to general financial characteristics and procedures. CBDWO differ slightly in terms of monthly average fees (4.30 US\$ average per month) and tariff delinquency (7%). However, there are more differences in terms of financial procedures, such as having bank account and audited financial statements. Finally, it is interesting to note some elements that reveal the presence of external actors (mostly different branches of the central government, including ICAA) to finance investments. More than 70% of all organizations have received some kind of external subsidy (some components of the infrastructure in most cases) while 56% have receive major external subsidies (all infrastructure of lines and tanks). However, 34% of communities also finance its investments by loans with banks. It is worth to notice that most of these communities are relative large; probably because banks require some degree of formality and warranties (assets) to give loans.

Finally, Table 5 presents the aggregated results of the individual evaluation of different dimensions of performance. The comparison between water quality and quantity reveals a lower level of satisfaction with the former. This finding is consistent with the fact that the most important problem listed by users in their respective community was water quality, above from the relevance of water quantity problems, high water fees, lack of information from water committee, among others.

	(1) Completely dissatisfied	(2) Somewhat dissatisfied	(3) Satisfied	(4) Absolutely satisfied
Water quality	2,31%	8,48%	21,85%	67,35%
Water availability	0,51%	3,86%	12,72%	82,90%

It is reasonable that water quantity is a less severe problem than quality at home. The reason is because communities are located in a region of the country in which precipitation and water availability are relatively abundant. Furthermore, given that all organizations have superficial sources to feed the system and most lack of chlorination practices, it is likely that contamination of water becomes a threat for these communities. However, water availability might become a greater concern in near future. As a matter of fact, more than 50% of water committee members interviewed considered that community growth will create a severe problem of water

scarcity in their communities, mostly because of the limited capacity of the actual infrastructure.

Quantitative analysis

This section presents the results of an ordered probit model to determine the factors that affect the perception of users regarding tap water quality at their homes. The individual evaluation of water quality, using a four level Likert scale, was used as dependent variable for the ordered probit. The analysis of the regression results presented in Table 6 reveals that the factors that affect the satisfaction of users with water quality are related to attributes of the infrastructure, the governance structure, the water board and users as well.

Table 6. Ordered Probit / Marginal Effects

Rank order (Likert scale)	(1) <i>Completely dissatisfied</i>	(2) <i>Somewhat dissatisfied</i>	(3) <i>Satisfied</i>	(4) <i>Absolutely satisfied</i>
Infrastructure characteristics				
Age of infrastructure (<i>years</i>)	0.0003	0.0013*	0.0022*	-0.0039*
# of households in community	0.0022***	0.0086***	0.0138***	-0.0246***
Functional chlorination technology (<i>dummy, 1=presence; 0=absence</i>)	-0.0146***	-0.0578***	-0.0989***	0.171***
Governance structure				
Savings (<i>thousands of local currency</i>)	-0.0006***	-0.0025***	-0.0040***	0.0072***
Delegation agreement (<i>dummy, 1=presence; 0=absence</i>)	0.00161	0.00625	0.0102	-0.0181
Annual reports to ICAA (<i>dummy, 1=presence; 0=absence</i>)	0.0125**	0.0459**	0.0706***	-0.129**
Written reports to community (<i>dummy, 1=presence; 0=absence</i>)	-0.0120*	-0.0436**	-0.0666**	0.122**
Water Quality Seal (<i>dummy, 1=presence; 0=absence</i>)	-0.0139***	-0.0655***	-0.142***	0.221***
Attributes of water board				
Average years as members	-0.0008	-0.0033	-0.0053	0.0095
Education (<i>% with more than High School</i>)	-0.0293**	-0.112**	-0.180**	0.322**
Participation in other organizations (<i>% of members participating</i>)	-0.0143**	-0.0549**	-0.0880**	0.157**
Gender threshold composition (<i>dummy, 1=30% or more women membership; 0=otherwise</i>)	-0.0007	-0.0027	-0.0044	0.0078
Characteristics of consumers				
Age	-0.0002*	-0.0008**	-0.0014**	0.0025**
Gender (<i>dummy, 1=woman; 0=man</i>)	0.0010	0.0041	0.0067	-0.0121
Education (<i>ordinal, increasing levels of education</i>)	0.0011	0.0043	0.0070	-0.0125

*** p<0.01, ** p<0.05, * p<0.1. N=726; Prob > chi2 = 0.0000

An examination of Table 6 indicates that some general characteristics of the infrastructure seem to affect the satisfaction of users with respect to water quality. First, the perception of water quality is related to the age of the infrastructure (average age is 17 years). In particular, if age of infrastructure is up by one year, the probabilities of being “somewhat dissatisfied” and “satisfied” increases by 0.13% and 0.22%, respectively. On the contrary, if age goes up by one year, the likelihood of being “absolutely satisfied” decreases by 0.39%. This finding might be explained because it is very likely that younger systems show better condition of infrastructure, which it might lead to less leaks and pipe breaks, and hence, it reduces the

possibilities of contamination of water by sediments or organic material. In fact, the contamination by sediments was the most frequent complaint of consumers regarding water quality.

Another important characteristic of the infrastructure is related to size. In particular, there is a significant and negative effect of size on the likelihood of being “absolutely satisfied” (see Table 6). This might be due to two explanations. First, size of the infrastructure is highly correlated with size of the group or the community. Following the argument of Olson (1971), the possibilities of reaching agreements in larger groups are low due to transaction costs and free riding. This might reduce the possibilities of the committee to perform tasks or to approve plans necessary to satisfy the needs of consumers in terms of water quality. However, it could be argued that this relationship could depend on contextual factors, such as social norms and socioeconomic characteristics (Poteete and Ostrom 2004; Agrawal 2001) but we couldn’t account for them. The second explanation might be more straightforward. Following similar findings in the literature (Kleemeier 2000), because size of infrastructure has an impact on maintenance tasks (such as repair leaks and pipe breaks) and the general complexity of the system (gravity forces, water pressure, among others), it is likely that committees in charge of smaller systems could deal more easily with problems that negatively affect the quality of water provided, such as leaks and breaks that increase the likelihood of contamination by sediments and organic material.

Another important distinction of the infrastructure is the existence of chlorination facilities. More importantly, these facilities were operating in those communities where the perception of people with water quality was the highest. This finding suggests that the existence of chlorination might be reducing the perception of risk by consumers as well as the incidence of water borne diseases. In fact, more than two thirds of the consumers that have reported becoming sick due to the consumption of tap water in last year lived in communities with non-chlorinated systems. In addition, our experience on the field helps us to realize that existence of these facilities imply an important qualitative distinction. In particular, it reflects the importance given by the committee on reducing the threats to human health in their communities and the potential vulnerability of their systems, especially because all water sources are superficial. The priority given to reducing these threats is reflected

in their willingness to commit resources to chlorinate the water and also in their efforts to enforce some particular rules that aim to guarantee the quality of water provided, at least from a bacteriological perspective. For instance, all chlorinated systems have performed at least one water quality analysis in the last 3 years, in contrast to 76% of non-chlorinated systems performing such analysis. Even more, 42% of chlorinated systems perform these tests every 3 months, while non-chlorinated systems have the same frequency in only 9% of the cases.

There are a set of characteristics of the CBDWO and the rules devised that seem to significantly affect the capacity of the organizations to satisfy the needs of consumers. The level of savings (that also includes spare parts that sums up to 8000 US\$ on average) is a necessary condition to properly satisfy the maintenance of the infrastructure. High levels of savings are extremely important to cover contingency expenditures. These unexpected expenses are usually related to leaks or pipe breaks due to storms or landslides, natural events that hit communities frequently. The incapacity to fix these problems promptly might lead to situations in which water is contaminated by sediments and/or bacteria.

In addition, high levels of savings suggest that these communities have the desire to commit resources to support their decisions and investments. This is a key component of a demand driven approach, and given that all these savings comes from water fees paid by local consumers, it might reflect the tendency to have cost recovery practices in place. Furthermore, in the analysis reported by Madrigal et al. 2010, they found that some motivational problems might exist to generate local revenues because of the expected support of the government in case of major necessity due to natural hazards or extremely deteriorated infrastructure. It might possible that those CBDWO that deviate from this paternalistic approach, developed a sense of ownership that further generates the incentives to proper maintain the system and perform the necessary tasks that satisfies the needs of those who are investing money.

One distinctive characteristic of CBDWO is related to their formal relationship with ICAA. However, we found no evidence that having a delegation agreement might enhanced the capacity of CBDWO to deal with specific problems and ultimately, increased their performance (see Table 6). This result supports similar findings (Madrigal et al. 2010) that state that argue that due to the lack of enforceability of the

delegation agreement and its low compatibility with local reality, it has no effect in changing behavior of CBDWO and hence their performance. This is a result with particularly important implications for policy makers because it suggests that the efforts to support the sector must go beyond a simple transformation in the legal status of the organizations.

The existence of some indicators of downward accountability, such as the regular provision of written reports to consumers about different investment plans, financial indicators as well as water quality, among other things, seems to play a significant positive role in influencing the perception of water quality. It might be argued that the effect is also transmitted through a general increase in the trustworthiness on the performance of the provider that affects how the risks of consuming tap water are perceived. The act of being accountable might increase the confidence of consumers about the capacity of the local committee to deal with different water issues, including water quality. Similarly in other studies, the trust in providers is linked to the perception of quality and risk (Fife-Schaw 2007; Doria et al. 2009; Doria 2010).

Additionally, it is likely that these mechanisms of accountability and information disclosure, coupled with regular elections, will increase the possibilities that consumers exert pressure on water committee members to act accordingly to their desires in relation to water quality (aesthetically or regarding technical standards of potability). Even that we couldn't document information about informal mechanisms of downward accountability, such as meeting in public venues, direct requests to committee members by phone or personally at their houses, given the relative small size of the communities, it is very likely that these mechanisms are complements to the formal mechanisms discussed above.¹⁵

It seems that all these mechanisms could be supported by other means of being accountable, such as the definition of external standards of performance and public disclosure of information. As a matter of fact, having a "Water Quality Seal" in the community, significantly affects the perception of people with water quality; in particular, it increases by 22.1% the likelihood of people being "absolutely satisfied". As mentioned before, this award recognizes those organizations that comply with strict technical standards of management that guarantee the potability of water and it

¹⁵ Madrigal et al. 2010 details about the existence of these mechanisms in similar CBDWO in rural Costa Rica.

provides diffusion tools that serve as mechanisms of public disclosure of information that might be affecting the perception of risk of consumers. The results suggest that this program might be extremely effective to provide relevant information to local users about the water consumed at home.

Given that the “Water Quality Seal” is sponsored and monitored by ICAA, it also works as an indirect mechanism for upward accountability.¹⁶ However, CBDWO voluntarily participate in this program. In contrast, other mechanisms of upward accountability are obligatory to all CBDWO but as discussed before (see Table 4), their enforcement is quite limited. Interestingly, some communities that comply with some mechanisms of upward accountability tend to have an opposite effect to that of “Water Quality Seal” on consumers.

The delivery of annual written reports to ICAA decreases by 12.2% the likelihood that water users are “absolutely satisfied” with water quality. Given the limited capacity from ICAA to follow its mandate to control all CBDWO, it might be possible that some criteria might be used to allocate the available resources to monitor CBDWO. One possibility is that ICAA monitor those organizations that presumably have problems or evident low performance. In fact, there is 30% more individuals that reported getting sick due to water in communities where they delivered reports to ICAA. In addition, 57% of people had an excellent perception of the work done by the local committee in communities that do not deliver reports to ICAA while 45% of people had an excellent perception of the work done by the committee in communities that deliver reports to ICAA. This might explain why it seems that in communities where water committees deliver written reports to ICAA, the satisfaction of water users with water quality is lower.

Some characteristics of the members of the water committee have an important impact on the perception of people of water quality, supporting the idea that the human capital of the local committee is a key asset towards the better performance of CBDWO. In particular, we found that higher levels of formal education of committee members have a significant positive impact on the performance of the organization, maybe because it allows them to better understand technical criteria

¹⁶ The “Water Quality Seal” is administered by the National Laboratory for Water Quality Analysis, a branch of ICAA. The rest of mechanisms of upward accountability are administered directly by a branch of ICAA that deals with CBDWO. There is very low, if any, coordination between the two branches. In that sense, sending a report to LNA does not preclude sending information to the other ICAA branch or viceversa.

related to the importance of some operational tasks necessary to guarantee good water quality.¹⁷

In addition we found a significant positive effect of the grade of interconnectedness of committee members with other local organizations. As long as the percentage of committee members that participate in other organizations in the community increases, the satisfaction of consumers tends to be higher. This suggests that the experience in other organizations might teach them how to work together and share cooperation values to deal with collective action problems in relation to water provision. Further, it suggests that networks, a component of social capital, enables them to reduce the costs of collective action through a better coordination of activities, sharing information and access to funds.

The nominal participation of women in water committees (measured as a minimum threshold of 30%) does not seem to significantly affect the analyzed dimension of performance of CDBWO. This result is similar to that obtained by Propoky (2004) in relation to women participation and project success in India but contradicts other relevant studies on the topic (van Wijk-Sijbesma 1998; van Wijk-Sijbesma 2001; Madrigal et al. 2010). However, our finding does not implies that the participation of women is not important at all because it might be very relevant for overcoming historical exclusion from decision making processes as well as other individual benefits such as self-esteem and empowerment.

Finally, Table 6 also presents some characteristics inherent to the surveyed users that affect their satisfaction with water quality, in particular, the probability of being “absolutely satisfied”. We found that as age increases, people are significantly more likely being “absolutely satisfied”. A positive effect of age on the perception of water quality was also found by Turgeon et al (2004) in urban settings. Studies reported by Doria (2010) suggest that age affects the perception of risk and organoleptics, however findings are contradictory and hazard dependent. In addition, demographic variables are often closely correlated. In this sense, due to cultural and social development aspects in rural Costa Rica, age might be negatively correlated to

¹⁷ We couldn't find any significant effect of specific training in water management on performance. This result might be due to how training was measured. We had information about the attendance or not to any training course. We couldn't account for the type of training (including intensity) and frequency of attendance by committee members. In that regard, some interviews with committee members suggested the importance of these distinctions. Future work might account for these important factors not deeply studied here.

formal education. In that case, one hypothesis could be that younger people have a greater likelihood to be exposed to information channels that increase their awareness and perceived risk of drinking tap water.

6. CONCLUSION

The definition and evaluation of performance is a complex task. Ultimately, a desirable goal of any CBDWO is to satisfy the needs of water users. Assuming that these individuals are the best judges of the service provided, well-designed surveys provide useful information about the service characteristics. Further, as Doria (2010) points out, ignoring the perception of people about water service can lead to public discontent and implementation problems of different policies. However, there is an urgent need to define technically-grounded benchmarking standards and public disclosure mechanisms that could serve as additional yardsticks to assess the relative achievements of CBDWO, the need to improve when needed and to increase the trust of consumers in their local providers.

In addition to the literature that finds that the satisfaction of people with water quality depend on properties such as taste, color or turbidity, this study shed some light about how some characteristics of the infrastructure and the organization that might create enabling conditions to satisfy the needs of water users with respect to this dimension of performance. As other studies in the literature, one key variable that affect the performance of CBDWO is related to the general components of a demand driven approach. However, it seems that other characteristics of the organization are also important. In particular, downward accountability mechanisms (including the Water Quality Seal) play a key role to exert pressure on committee members to act according the interests of consumers and to enforce rules that increase the likelihood of having an organization that effectively solves different collective action problems embedded in drinking water provision. The role of human capital of the water committee and its relation to social capital in the community cannot be neglected in this regard.

Our findings have important policy implications for the water sector in Costa Rica. First, the descriptive analysis shows important gaps differences among CBDWO in terms of chlorination practices, accountability mechanisms and training of local committee members. Public policies that aim to support this sector must be properly

targeted to bridge these gaps. Second, the relevance of the demand driven approach demonstrates that CBDWO could offer a service that satisfies the needs of local people, even though they have received little financial help from outside. This evidence shows that communities could have the incentives and capacity for being financially self sufficient and highlights the relevance of further study the criteria to give subsidies to CBDWO. Third, given the lack of evidence that the delegation agreement positively affect CBDWO's performance, the legal transformation promoted by the government of CAAR into ASADAS might ineffective without a more comprehensive program of support. Fourth, one plausible way to promote effective accountability is to foster the adoption of the "Water Quality Seal" as a mean to define verifiable and comparable standards that could be easily identified by water users and governmental authorities. However, more research is needed to evaluate the overall effectiveness of this program.

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8. APPENDIX

Characteristics of surveyed users	
Total number of surveys	778
% of women interviewed	69%
Average age	46
Average years of living in the community	32
Average number of people per household	4
% with only primary education (max 6 years of education)	72%
% with secondary education (max 6-12 years education)	18%
% with higher education (more than 12 years of education)	6%
% of houses with telephone	79%
% of houses with internet access	6%
% of houses with cable television	15%
% of households that own the house	89%