

Determinants of Performance of Drinking- Water Community Organizations

*A Comparative Analysis of Case Studies in
Rural Costa Rica*

Róger Madrigal, Francisco Alpízar, and Achim Schlüter



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Abstract

This paper presents an institutional analysis of the underlying factors affecting the performance of drinking-water community 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. This research tries to understand how a complex configuration of geophysical characteristics of watersheds and infrastructure as well as governance and socioeconomic attributes of local users affects three key dimensions of performance in rural communities: financial health, infrastructure condition, and user satisfaction. Using a qualitative approach and matching techniques to ensure comparability, the paper analyzes four communities in depth. The main results highlight the relevance of a demand-driven approach, coupled with local accountability, working rules for tariff collection and infrastructure maintenance, and appropriate support from the government as the main conditions that promote higher levels of performance.

Key Words: institutional analysis and development (IAD) framework, social ecological system (SES), propensity score matching

JEL Classification: D71, H41, Q25

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Contents

Introduction.....	1
1. The Water Sector in Costa Rica	2
2. Theoretical Framework.....	3
3. Methods.....	7
3.1. Secondary Data Available.....	7
3.2. Case Selection	8
3.3. Survey Instrument Design and Collection of Primary Data	9
4. Results	11
4.1 Operational Rules.....	12
4.2 Collective Choice and Constitutional Rules	12
4.3 Accountability.....	15
4.4 Property Rights	17
4.5 Demand-Driven Approach.....	18
4.6 Motivational Problems.....	20
5. Conclusions.....	21
References.....	24

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Introduction

Access to safe drinking water and sanitation is a global concern, especially as a Millennium Development Goal,¹ and in recent years, it has been increasingly addressed as one of the basic human rights of nations (UNDP 2006). However, in most rural areas of the developing world, safe drinking water from an improved source and sanitation services remain unacceptably lacking (WHO-UNICEF 2006). Despite the importance of these issues in the political agenda, water policies in many countries do not promote the creation of appropriate institutions to manage water needs and enhance supply and maintenance capabilities (Saleth and Dinar 2004).

Over the past 50 years, a series of institutional arrangements, ranging from strong governmental participation to decentralized efforts, have been touted as panaceas to improve water management. However, each of these approaches has failed as a blueprint strategy or policy prescription largely because of the variability of local situations and the difficulty of transplanting institutions from one context to another (Meizen-Dick 2007).

Even though Costa Rica has one of the highest coverage ratios of drinking water for its population in Latin America (WHO-UNICEF 2008), the disparities in access to drinking water between urban and rural areas persist. In rural Costa Rica, drinking water is provided by different types of community organizations, in contrast to the prevalence of government water utilities in

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¹ <http://www.un.org/millenniumgoals/>

urban areas. Unfortunately, some water community organizations leave consumers exposed to poor water quality. Moreover, their poor organizational and financial performance further jeopardizes the future provision of potable water. Interestingly, for some rural community organizations, the situation is the opposite. By contrasting these two situations, we hope to analyze how different institutional arrangements generate incentives that ultimately affect the sustainability of resource use, as well as perceived benefits.

Despite the importance of the issue of access to safe water and the great disparity of performance within rural water-community organizations, there has been no systematic evaluation of the circumstances in which some organizations perform well while others do not. Furthermore, given that the central government has historically designed different public policies for this sector, an adequate assessment of the conditions that affect performance in local organizations is necessary to avoid policy prescriptions that fail to capture the particular socio-ecological interactions present in every watershed.

Our study is based on a careful statistical selection of contrasting case studies and a qualitative institutional analysis that aims to explore the causal mechanisms that explain why some communities succeed or fail to solve collective action problems related to providing drinking water. In particular, our main goal is to understand how effective rules—mediated by infrastructure, watershed characteristics, and community attributes—produce different patterns of interactions that lead to high or low performance.

This paper is organized as follows. The next section describes the general characteristics of the drinking water sector in rural areas of Costa Rica. Section 2 presents our theoretical framework and places our study in the relevant literature. In section 3, we present our research design, including case selection strategy and collecting data protocols. The last two sections include our results and conclusions, respectively.

1. The Water Sector in Costa Rica

Historically, the Costa Rican government has assumed a direct role in the provision of basic services to the population, including drinking water. The ICAA (Costa Rican Institute of Water and Sewerage, by its Spanish acronym) was created in 1961 with the dual purpose of oversight on one hand, and designing, constructing, and managing drinking water infrastructure in urban and rural communities on the other. From the 1960s to the 1990s, there was a boom in the construction of infrastructure to provide drinking water, primarily funded by the government or

international loans. In many cases, ICAA delegated administration to local communities and these cases are the subject of our analysis.

Besides ICCA's centrally administered aqueducts, there are two types of community-based organizations: CAARs (rural aqueduct administration committees) and ASADAS (administrative associations of aqueducts and sewerage systems). There are more than 1,000 CAARs and ASADAS (see table 1) responsible for providing water to nearly one million people (more than 60 percent of people in rural areas). The main difference between the two types of organizations is that ASADAS have a formal delegation agreement with ICAA, which transfers rights (water withdrawal and management) to local organizations, while also providing a formal framework of higher accountability. The CAARs are considered informal organizations. In recent years, ICAA has been actively promoting the transformation of CAARs into ASADAS with the aim of strengthening their legal status and, hence, their performance. However, from the theoretical point of view, there is no guarantee that this policy blueprint will create an effective set of rules to ensure an adequate provision of water in rural areas.

Table 1. General Statistics of Principal Water Providers in Rural Areas

Administration	CAARs	ASADAS	Rural ICAA
	<i>Community based</i>		<i>Centralized</i>
No. of organizations	434	658	33
Mean population served	821	997	12,447
Median population served	430	546	8,148
% Potable water *	51	58	N.A.
% Gravity systems	47	51	N.A.

N.A. = not available

* Based on microbiological criteria

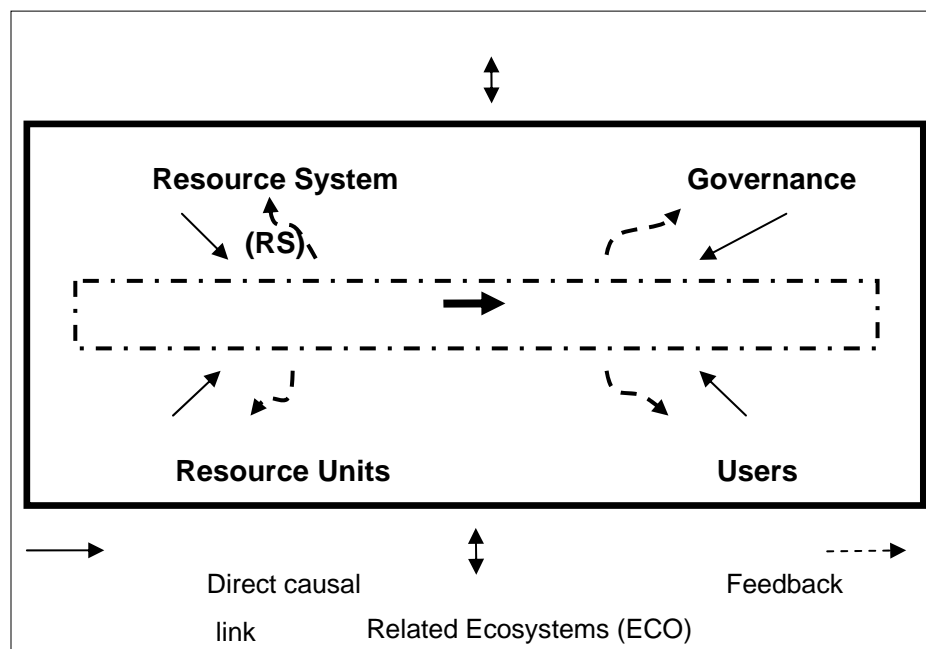
Source: Authors' calculations, based on ICAA (2007), ICAA (2008), and LNA (2008)

Finally, in addition to the necessity of increasing the amount of potable water for users, there are other challenges for rural community water organizations in Costa Rica (ICAA-OPS-OMS 2002): 1) to a great extent, revenues do not allow full cost recovery, which leads to a very low financial resilience; 2) approximately 50 percent of the infrastructure of rural aqueducts is in normal-to-poor condition; and 3) most of these organizations suffer from poor organizational and operational practices.

2. Theoretical Framework

Broadly speaking, the interactions between humans and ecosystems are described in the literature as social-ecological systems, or SESs. (Anderies et al. 2004). Water provision can be considered a particular case of SES because an adequate drinking water supply does not depend exclusively on engineering solutions for infrastructure. The characteristics of watersheds, as well as human decisions on land use (Bruijnzeel 2004)—especially in recharge areas—are also relevant because they have a direct impact on the water needed to flow through this infrastructure. Furthermore, the incentives for people to devise rules to access, allocate, and consume water affect its supply, which in a recursive manner may generate a new pattern of incentives for using the services provided by ecosystems.

Figure 1. A Multi-Tier Framework for Analyzing a Social-Ecological System



In this paper, we adapt a multi-tier framework (figure 1) for analyzing SESs developed by Ostrom (2007). This conceptual map enables us to organize highest-tier variables that can affect the patterns of interactions and outcomes observed in drinking water systems. At its broadest level, this theoretical framework analyzes how the characteristics of the resource system, the resource units generated by it, the attributes of the system's users, and its governance structure jointly work together to achieve particular outcomes in any time and place (ibid.). This broad set of variables

and outcomes might affect and be affected by the larger socioeconomic, political, and ecological setting in which they are embedded (*ibid.*).

For our analysis, we decomposed the highest-tier variables into third and fourth tiers whenever more detailed variables were necessary.² These variables were selected after a careful literature review of the key elements that foster collective action in different common-pool resources settings, particularly those related to drinking water (Watson et al. 1997; Lam 1998; Agrawal 2001; Ostrom 2007).

Similar to the findings in the literature of common-pool resources, it is likely that characteristics of the resource system and its units create different challenges for communities in devising rules to solve water provision and allocation problems. In addition to conditions that naturally affect hydrological cycles and land use, the characteristics of the infrastructure and technology are also important contextual factors influencing the creation of different rules. For example, the size of the infrastructure has a powerful effect on maintenance tasks (such as repairing pipe breaks and blockages) and diagnosis of problems, which increases the technological complexity (Kleemeier 2000). Finally, the water source dictates the selection of the appropriate technology to convey water (gravity versus pumping systems), which in turn affects the general complexity of the system, as well as the costs and technical skills needed to run it properly.

On the other hand, different user attributes can also influence the rules created to manage collective action. In particular, earlier theoretical works (Olson 1971) suggested that the possibilities of larger groups reaching agreement are low, due to transaction costs and free riding. However, Poteete and Ostrom (2004) and Agrawal (2001) argued that the effect of size depends on contextual factors, such as social norms and socioeconomic heterogeneities, respectively. Regarding social capital, the empirical evidence indicates that the existence of other non-water-related networks and associations in a community helps solve collective action problems, such as the challenges of providing drinking water (Kähkönen 1999). The role of the leader—who facilitates the design of rules, norms, and strategies in a community—has been related to the ability of groups to gain autonomy and design local institutions (Basurto 2007). Finally, dependence on the resource is considered a necessary condition for the emergence of local institutions because they may require users to invest time and effort (Stern et al. 2002).

² Appendix A provides an example of second-tier variables used in the analysis.

Institutions are a core concept in the structure of a governance system. Institutions embody the set of working rules that forbid, permit, or require some action or outcome (Ostrom 1990). These working rules should be common knowledge and need to be monitored and enforced. They are nested in three different levels of analysis: the operational level, the collective choice level, and the constitutional level (Ostrom 1990). Even though the literature on common pool resources has devoted much attention to how working rules affect outcomes for common pool resources (Ostrom 1990; Agrawal 2001; Ostrom 2005), few studies explicitly analyze the impact of institutions in drinking-water community systems.³

The role of the local governance structures in the efficient management of common pool resources is even more important in light of public policies that promote decentralized institutional arrangements. This trend, mostly motivated by the limited local administrative capacity of central governments, shortage of governmental funding, and pressure to democratize decisionmaking processes (Ribot 2002 and 2004; Knox and Meinzen-Dick 2001) is not without pitfalls (Ribot 2002 and 2004). One of the most relevant factors that allow decentralization to benefit local populations is local accountability (Agrawal and Ribot 1999).

Finally, an important methodological consideration is our working definition of performance—the achievement of certain objectives. However, there is no scholarly agreement on what objectives must be considered or what methods must be used to measure these outcomes in water community organizations.⁴ On the contrary, there is implicit agreement that performance is a multidimensional concept that includes water quality and availability, consumer satisfaction, and financial aspects, among others (Narayan 1995; Sara and Katz 1998; Gross, van Wijk, and Mukherjee 2001; Stalker 2005; Thorsten 2007; Stalker et al. 2008).⁵

We selected the state of the infrastructure condition, consumer satisfaction, and financial health as the three relevant dimensions of performance that are especially suited to revealing essential tasks that must be carried out, in order to overcome collective action problems in water

³ Sara and Katz (1998) are one of the few exceptions who at least tried to recognize the importance of different types of rules in these settings.

⁴ The process of benchmarking and evaluating the performance of water utilities in urban areas of Latin America has been extensively developed in recent years (Corton 2003; Berg and Lin 2007; Berg and Corton 2007). However, given the relevance of rural water-community organizations in the region, there is a surprisingly lack of studies that try to measure performance in this sector.

⁵ There is no theoretical justification in the literature for preferring one criterion to another. A similar problem has been reported by Lam (1998) in the literature related to performance of irrigation systems.

community systems. These three dimensions of performance are interlinked. Raising funds and allocating them properly is one of the most important objectives that community water organizations must achieve in order to solve water provision problems. We include measurable objectives—such as the ability to generate a surplus after paying for operation and maintenance costs, as well as tariff delinquency—when assessing the general financial health of such organizations. On the other hand, the conditions of both the existing infrastructure and the natural areas are closely linked to the previous dimension and, again, are key to the long-term success of the resource system. These variables are included in dimensions related to the condition of the infrastructure and summarize some of the principal tasks involved in “producing” water and maintaining the infrastructure (e.g., condition of infrastructure, protection of natural areas near intake points, water quality). Finally, subjective evaluation by users can reveal valuable information about the effectiveness of the organization to provide good service.

3. Methods

In our methodological approach, the theoretical framework serves two main purposes. First, it provides structure for the data collection, and second, it allows us to use the characteristics of the physical world, the users as the background from which alternative governance systems and community dynamics emerge. Whenever relevant, we do pay attention to feedback effects. Moreover, using statistical techniques, we attempt to reduce the heterogeneity of the physical world and users as much as possible to focus on the role of governance and dynamic interactions on performance.

3.1. Secondary Data Available

The available data came from three different sources: 1) ICAA’s official database on general characteristics of rural organizations (location, population served, type of feeder technology, etc.), 2) the National Water Laboratory’s (LNA, by its Spanish acronym) official database on water quality by organizational type, and 3) the Digital Atlas Project of Costa Rica that uses GIS (geographic information system) data. We merged these data sources into one single database and used this data to select our case studies. Our merged database on CAARs and ASADAS contained 192 observations in the Metropolitan Region, one of the seven administrative regions described by ICAA.

We focused on the Metropolitan Region for several reasons. One, the largest share of people (19 percent) served by rural water organizations lives in the Metropolitan Region. Two, it is the second most important region in terms of number of rural water organizations (16 percent of

the total). Three, focusing on just one region allows better control of geographical characteristics that might influence hydrological and hydro-geological patterns. Four, it ensures that all rural organizations fall administratively under the same regional team of ICAA. This last point is particularly important because some peculiarities of the relationship between the ICAA regional administrative units and regional local water providers might affect performance.

3.2. Case Selection

Given the potential biases and problems associated with pragmatic selection and complete randomization, the argument for a purposive sampling of potential case studies seems strong (Seawright and Gerring 2008). Given the different techniques for selecting cases, depending on research objectives (ibid.; Gerring 2007), we chose the most similar cases because we were interested in situations where water community systems are similar in terms of exogenous control variables (X_1 = remoteness, precipitation, size, feeder technology, age), but are different in at least one explicative dimension (X_2 = type of organization) and the outcome (Y = performance). Controlling for some characteristics will reduce the number of confounding factors in the relationship between explicative variables (those in table 2) and outcomes.

In choosing our case studies, we were forced to use a much simpler definition of performance because we did not have ex-ante information for our three selected dimensions. As a result, we used water quality as a proxy for performance.

As recommended in the literature (Seawright and Gerring 2008; Gerring 2007), we used propensity score matching (PSM) to identify similar cases from the cross-sectional, secondary data from the Metropolitan Region. The estimation involved pairing treatment and comparison units that were similar (no exact matches) in terms of their observable characteristics or covariates. We selected four cases, a high- and a low-performing example of each of the two organizational types in the region.⁶ Table 3 includes the main characteristics of organizations selected.

⁶ The details of this estimation can be found in Madrigal et al. (2009). To satisfy the objectives of comparability and representativeness (in terms of number of families per community), we applied a two-step procedure. First, we applied PSM to estimate the fitted values, or propensity scores, that define the probability of each case being assigned to the treatment group (organizational type). We then reduced the population of cases to those located within a 95% confidence interval around the median propensity score. From this subsample, we selected the four cases closest to the median, assuring that they differed in terms of water quality.

Table 3. General Features of Organizations Selected in the Metropolitan Region, Costa Rica

	CAARs (rural aqueduct administration committees)		ASADAS (administrative associations of aqueducts and sewerage systems)	
	<i>CAAR-high performing</i>	<i>CAAR-low performing</i>	<i>ASADAS-high performing</i>	<i>ASADAS-low performing</i>
Name of community	San Rafael de Arriba	Chirracá, Los Calderón	Desamparaditos	Bajo de Jorco
System type	Gravity	Gravity	Gravity	Gravity
Metering	No	No	Yes	Yes
Water quality (based on microbiological tests)	Potable	Non-potable	Potable	Non-potable
Infrastructure age	26	28	28	15
Population served	435	454	840	693
Number of houses	145	108	200	165
Households density*	22	32	36	89
Elevation (meters above sea level)	800	1000	800	700
Precipitation (mm)	3000	2500	2500	3000
Delegation agreement signed with ICAA	No	No	Yes	Yes
Social development index per district**	50.3	43.2	57.6	43.2
Distance to the closest regional ICAA office (km)	5	2	7	10

* Water connections (households) per meters of lines longitude, as assessed in the fieldwork.

** Social development indices (SDI) per district are compound by educational infrastructure, access to special educational programs, child mortality, school attendance, and household consumption of electricity, among other indicators.

3.3. Survey Instrument Design and Collection of Primary Data

We designed a field manual based on the theoretical framework described in the previous section.⁷ One important component of the manual was dedicated to evaluating performance. Table

⁷ This field manual builds on a similar manual developed by the International Forestry Resources and Institutions (<http://www.sitemaker.umich.edu/ifri/home>) to study the relationship between people and forests around the world. We kept a structure and data-collection strategy similar to IFRI's, but modified the questions to fit the problem at hand.

4 presents details about the indicators included in each dimension of performance, as well as the procedure to aggregate them into indexes.⁸

Table 4. Evaluation of Performance

Dimension	Description	Indicators	Source of information
Infrastructure condition	Dummy variables were associated with desirable technical characteristics* of the resource system (1 = presence, 0 = absence). The average of dummies (multiplied by 100) was used as overall score.	25 indicators were measured in relation to water source, different components of infrastructure, and water quality assessment.	All indicators were measured on the field, based on technical criteria.
User satisfaction	Water users expressed their opinions regarding different features of water service. The percent of households satisfied with different indicators of service was estimated. An overall score was calculated as an average of all indicators included in this dimension.	Included continuity of water service, water quantity satisfaction, absence of illness caused by drinking tap water, perception of work done by water committee.	Users were interviewed privately (members of the actual committee and their direct relatives were excluded). 10%–15% of houses were randomly sampled in each community.
Financial health	Dummy variables were associated with the achievement of different objectives (1 = objective achieved, 0 = otherwise). The average of dummies (multiplied by 100) was used as an overall score.	Included fee collection level, cost recovery, and investment self-sufficiency.	Financial records of the organizations.

* This assessment was based on a similar evaluation proposed by the official government laboratory for water quality assessment and vulnerability in rural water community systems (Valiente 2006).

We must acknowledge some caveats to our approach to measuring performance. First, our indicators lacked an explicit temporal dimension that allowed us to judge how performance might evolve over time. We included a temporal dimension only indirectly because past and present financial, health, and infrastructure conditions might be good predictors of future outcomes. Second, when we combined several indicators into one single score per dimension, we assumed perfect substitution among them. The alternative was to use weights derived from expert advice,

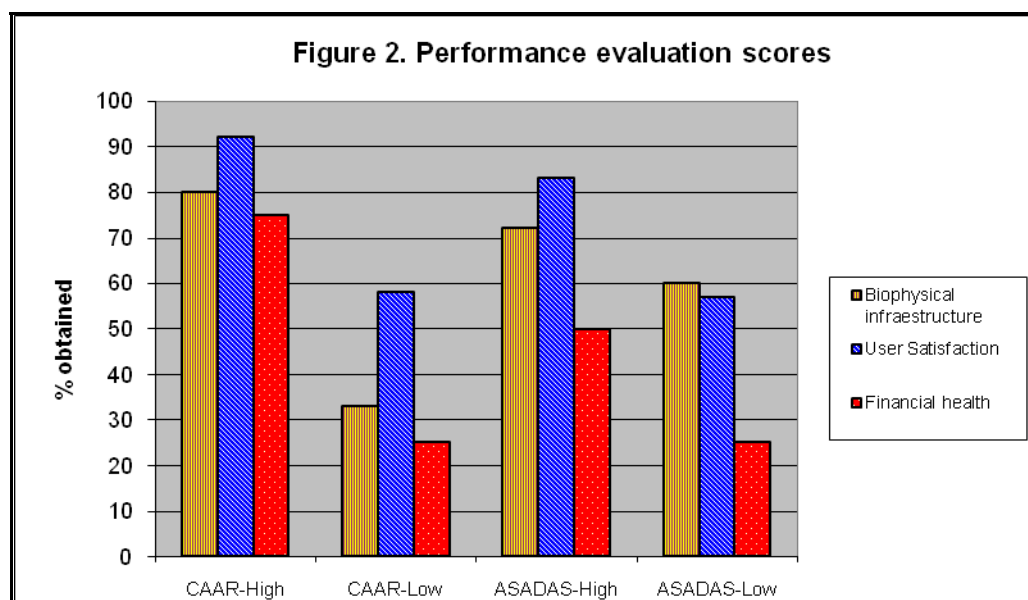
⁸ Further details are available from the authors by request.

but we chose not to open that door. Third, as mentioned before, one would expect the three dimensions of performance to be correlated, so it was not possible to discuss the effect of a particular variable on one dimension only (i.e., keeping the other two constant).

Given the large quantity of questions and the level of detail in some of them, we used different sources of information. Some of these sources were complementary. The main sources were direct observation; content analysis of official records; official databases from ICAA and LNA, plus GIS data; and interviews of water community users, water committee, and key informants, as well as ICAA and LNA officials. To gather all the required information for the manual, we spent four weeks, on average, in each of the analyzed communities.

4. Results

Figure 2 presents the results of the application of the performance indicators described above.



Based on our evaluation of performance, CAAR-high and ASADAS-high scored the highest in each of the analyzed dimensions. Despite having different formal governance structures, they had similar levels of success in meeting performance objectives, including particularly high levels of user satisfaction. The low-performing ASADAS showed a relatively high level of performance success, with respect to maintenance of infrastructure, which was perhaps due to recent investments in the system. As expected, figure 2 shows a clear correlation among the three dimensions of performance, further reinforcing our systemic approach. This suggests that the way

communities solve provision problems may affect the physical process of production (and vice versa), and this process affects the general satisfaction of local users.

As mentioned earlier, we emphasize how the governance system—particularly the existence or absence of some rules, which are mediated by attributes of the resource system and its users—explains the differences in performance. The in-depth analysis of each separate case and the comparison of the four cases helped us discern which of the large list of potential variables and their interactions are more likely to have a major impact on performance.

4.1 Operational Rules

At the operational level (rules that affect day-to-day decisions) of high-performing communities, there is a clear set of rules governing the conservation of natural areas near water-intake points and water-quality monitoring sites, preventive and corrective maintenance of the infrastructure, and financial procedures. A detailed inventory is provided in table 5.

4.2 Collective Choice and Constitutional Rules

Officials or decisionmakers set collective choice rules to define the management and operational activities, while constitutional rules determine who is eligible to craft the set of collective choice rules, which in turn affect operational activities and performance (Ostrom 1990). It is important to add that, in the case of ASADAS, the central government actually requires implementation of some of these rules and provides strict guidelines. The main issue, then, for the ASADAS is the enforcement of these rules.

Our conclusions on collective choice and constitutional rules were quite clear cut. High-performing organizations regularly enforce them and low performers do not. Table 6 shows our inventory of this type of rules.

In high-performing communities, local committees at least try to enforce the national water law that establishes a protection buffer of 100 meters around springs and water-intake points. They define and monitor rules that forbid animals, latrines, and agricultural activities in these areas. The presence of these types of rules is particularly important because none of the organizations chlorinates water and all water sources are on the surface, which increases the vulnerability of beneficiaries to any bacteriological infection (LNA 2008).

Table 5. Operational Rules

Rules	CAAR-high	CAAR-low	ASADAS-high	ASADAS-low
	<i>0 = no rules or not enforced; 1 = rules enforced</i>			
TOTAL	8	2	5	2
<i>For tariffs</i>				
The water use is regulated by metering systems and tariffs.	0	0	1	1
The place, day, and mode of payment are clearly established.	1	1	1	0
Sanctions for delinquency are clearly established and enforced.	1	0	1	0
Sanctions for delinquency are gradual, corresponding to the payment delay (number of days), and there are reconnection costs.	1	0	0	0
<i>For infrastructure maintenance and protection</i>				
Rules for ensuring preventive maintenance of infrastructure are enforced.	1	0	0	0
Rules for repairing breakdowns are enforced.	1	1	1	1
Rules to protect natural areas near intake points are enforced.	1	0	1	0
<i>For water treatment</i>				
Water quality is monitored with microbiological tests (paid for by the water committee)	1	0	0	0
Tanks are cleaned periodically.	1	0	0	0

Two exogenous factors seemed to play large roles in the ability of communities to establish good operational rules. One, an obstacle to enforcing rules that protect intake points in CAAR-low and ASADAS-low, was the distance from the community to the springs and the natural difficulty of accessing these areas. The second factor was the technical complexity of the water system infrastructure. Despite similarities of feeder technology (gravity or pumps) and the age and number of lines in all systems in the sample (see table 3), there were other resource-system characteristics that created significant differences in the four systems' complexities that affected enforcement of operational rules. In particular, variations in density of connections (to households) affected the ease and the costs of detecting failures. Furthermore, given that gravity is the feeder technology in these systems, variations in altitude between the storage tank and the houses served significantly affect water pressure and, hence, the likelihood of infrastructure breakdowns and a sufficient and continuous supply of water to some houses. Considering these characteristics, it is interesting to

note that the best-performing systems tended to have relatively simple operational infrastructures, while the low performers had systems with more technical challenges.

Table 6. Collective Choice and Constitutional Rules in Use

Rules	CAAR-high	CAAR-low	ASADAS-high	ASADAS-low
<i>0 = no rules or not enforced; 1 = rules enforced</i>				
TOTAL	6	1	6	1
There is a written regulation designed by the community. This set of working rules seems to work effectively.	1	0	1	0
A general assembly is held periodically.	1	0	1	0
The water committee has periodic meetings.	1	0	1	1
There is a clear mechanism, regularly enacted, for electing the water committee.	1	1	1	0
There are accepted procedures to remove members of the committee before elections.	1	0	1	0
There are accepted and known procedures for reaching decisions in water committee meetings.	1	0	1	0

In CAAR-high and ASADAS-high, the users appoint the water committee members in a general assembly held every two years. The committee members must follow a set of written rules that is also defined by the community. These working rules establish clear responsibilities related to operation, investment, and management of the system. In contrast, low-performing organizations have no clear mechanisms for calling general assemblies and for electing committee members. In the case of ASADAS-low, even though it has a set of rules defined by the central government, the ability to enforce these rules is limited. In addition to an obvious lack of accountability, leaders see no congruence between the rules and the reality of their communities, so they do not enforce them. In some cases, they claim not to understand the meaning of many of the external rules well.

This last point brings us to the human capital of the members of the water committees. In the case of CAAR-high, it is particularly interesting to notice the relatively high stability of water board members (members serve seven years on average) and the strong leadership of the president. These factors, coupled with training courses on drinking water provision, give water committee members a good knowledge of how the local water system works and particularly a clear

understanding of the importance of preventive infrastructure maintenance and the protection of areas near intake points.

It is interesting to note that the CAAR-high organization had the highest number of committee members who also actively participate in other local organizations. This may suggest the existence of a learning effect that enhances their ability to craft and enforce rules governing water delivery in the community. In addition, the leadership is clear, which positively affects performance in CAAR-high. The president and the treasurer know how to initiate collective choice processes, given their organizational experience on the water board and other local organizations, and they also bring their technical capacity, charisma, and commitment to the community to bear. The community of San Rafael recognized such leadership recently by giving their water committee president an award for outstanding contributions to settlement development and water provision security.

In the case of CAAR-low and ASADAS-low, the role of human capital and leadership is less straightforward. In principle, one prefers that water board members be highly educated, have field experience, and show significant dedication to the community. In the case of CAAR-low, water board members have the education, but lack the training in water systems, and—more importantly—their education is coupled with high opportunity costs that limit their dedication.

In contrast, the committee members of ASADAS-low have low literacy levels and no formal training in water provision, but they have empirical expertise in managing the system. It is important to stress that leadership is important, provided that a transparent system of replacement is in place. In the case of ASADAS-low, presidents have had a strong, historical leadership role that is characterized by political experience and ability to deal with the bureaucratic system to access funds. However, this strong leadership may crowd out active participation by other members of the community, which further decreases the sustainability of the water organization. In fact, many of the key informants in the community expressed their concern about the future of the organization should the actual president no longer be able to perform to his responsibilities.

4.3 Accountability

In formal terms, all drinking-water community organizations are formally accountable to ICAA. However, we found no evidence of appropriate mechanisms for higher accountability, even for ASADAS, where a formal delegation agreement exists. Different reasons may explain this lack of accountability by higher authorities in the communities we analyzed. First, the centralized governmental institutions are embedded in a complex legal hierarchy. More than 20 public entities

have jurisdiction over water resources, and more than 110 regulations already exist for the sector (Aguilar 2005). This confusing scenario inevitably results in little, if any, direct and permanent supervision from the government, and there is no clear agency to receive reports or resolve complaints. This problem is further exacerbated by the remoteness of the four communities studied. In summary, accountability higher up does not affect performance, and formal delegation agreements are irrelevant in this respect.

Table 7. Accountability Rules

Rules	CAAR-high	CAAR-low	ASADAS-high	ASADAS-low
<i>0 = no rules or not enforced; 1 = rules enforced</i>				
Total	10	2	7	3
Currently, the organizations maintain these types of registers:				
- Users list	1	1	1	1
- Delinquency list	1	0	1	0
- Annual or monthly budgets	1	0	0	0
- Financial statements	1	0	1	0
- Accountancy books	1	1	1	1
- Progress reports on different activities or projects	1	0	0	0
There is a defined place to file relevant documents.	1	0	0	0
The water committee presents annual written reports of activities to users.	1	0	1	0
The water committee presents annual written reports of activities to ICAA.	0	0	1	0
There is an established mechanism to send out periodic information on future meetings, infrastructure maintenance, etc.	1	0	0	0
Periodic elections of the committee members are held.	1	0	1	1

Community accountability, however, seems to be an important factor affecting performance. Table 7 shows that high-performing community organizations keep detailed information about revenues and expenditures that is accessible to any member of the community, properly track delinquency, and have effective mechanisms by which local users can exert pressure on committee members to include their demands in decisionmaking processes.

It is interesting to highlight the case of CAAR-high because it shows clearly how different mechanisms of local accountability work. There are formal and informal arenas in which officials can be sued. The formal arenas are routine assemblies held twice a year that all people from the

community can attend, ask questions, and vote as necessary. The president and treasurer present a public report of activities, supported by audited financial records and other relevant written documents. In case of dissatisfaction with the performance of the committee, the community can remove any or all members at any time via a formal procedure.

In addition, informal arenas for local accountability frequently turned up in our interviews. Informal arenas and related procedures are difficult to identify and measure, but our interviews with water committee members and other key informants hinted at some. Many informal meetings take place in public venues, such as churches, local schools, and the street, among others. However, given that most community members live and work in the same place, it is likely that they can easily reach the committee members and address them about water provision. In addition to these public venues, most people in the community know the members of the committee and where they live. Committee members have mentioned that it is common for users to call them directly on the phone or visit their homes to request help or to complain about general service. In all cases, this interaction is the result of the appropriation of the water organization by all members of the community and the high level of dedication of water board members.

4.4 Property Rights

Based on Schlager and Ostrom (1992), we distinguished different property rights related to water and land. Not surprisingly, we found that none of the communities had a complete bundle of rights, but we did find that the high performing organizations tended to have clearer and better enforced property rights.

In Costa Rica, the state owns all underground water resources and gives access and withdrawal rights for defined periods to anyone who applies for a permit. By law, all water community organizations must request these rights. Nevertheless, only ASADAS-high organizations have formal permits and only for specific springs. Even though we found no evidence that the absence of formal rights in the other communities affected actual performance, it might be the case that their capacity to deal with future potential conflicts for access and use of water with external actors would be affected.

In the case of property rights on land around springs, the two organizations that show better performance at least have access and management rights over these areas. More importantly, as mentioned before, these communities exercise these rights by enforcing specific operational rules to maintain land cover and limit the presence of animals or other potential sources of contamination. Finally, we observed that some communities hesitate to issue and implement

property rights on land, water, and infrastructure because they lack a sense of ownership of the water resource. This has been identified as one of the main reasons that donor-funded infrastructure projects fail (Gibson et al. 2005).

4.5 Demand-Driven Approach

How do community dynamics emerge from the characteristics of the resource system and its users, and how do they affect the measure of performance? As mentioned before, three types of organizations provide drinking water in rural areas: 1) centrally administered organizations (ICAA), 2) community-based organizations with formal delegation agreement (ASADAS), and 3) informal community organizations (CAARs). ICAA's policy is to convert the informal associations into formal community organizations with the aim of making them accountable to the national authority. In three of the communities we analyzed, there have been at least two different formal structures for water provision.

For both CAAR-high and ASADAS-high organizations, we observed a process that started with a centralized organization administered by the national authority, ICAA. This model was substituted in both cases by an informal organization (CAAR) and then, later, one added a formal agreement (ASADAS). In the case of the ASADAS-low organization, it started as a CAAR and eventually formalized its agreement with ICAA. Changes from ICAA to CAAR have been motivated by a demand-driven approach that generated new incentives and governance systems that positively impacted performance. It is important to note that this approach required diverse forms of social capital to create enabling conditions. On the other hand, changes from CAAR to ASADAS were due mostly to the pressure from the central government, and we found no significant changes in governance system characteristics that seem to impact performance.

The demand-driven approach in CAAR-high and ASADAS-high has three distinct characteristics that are described below:

1. Initiating action: Interviews with key informants revealed a common motivation for institutional change, namely, the central authority provided poor service despite charging a relatively high tariff. In particular, repairs were slow because government officials lived far away from the community and were not directly affected by breakdowns. Moreover, the administrators of the aqueduct were accountable to the central government and usually ignored the complaints of local users.

In both communities, this triggered a local initiative to request administration of the system, which eventually succeeded (in 1991 for CAAR-high, and 1981 for ASADAS-high). In

the case of ASADAS-high, the community was already organized and had extensive experience in fund raising and devising effective rules to coordinate collective action in the community.

2. Willingness to pay: Some major improvements in infrastructure were necessary at the time the CAAR-high and ASADAS-high requested administration of the water system from the government. Although the central authority provided most of the necessary material to rebuild the infrastructure, communities also contributed, especially labor. Currently, community members pay water charges and delinquency is very low (<10 percent). Finally, less quantifiable but not irrelevant, the communities also paid more to negotiate with the government, as well as paying the cost of gathering information about legal procedures and other relevant guidelines from other water community organizations and key informants.

3. Participating in infrastructure and institutional design: Defining and measuring participation is a difficult task because it is a “multidimensional dynamic process, which takes varying forms and changes during the project cycle and over time, based on interest and need” (Narayan 1995, 7). Keeping this complexity in mind, participation as defined by our study means that communities have relevant information about the system; their opinion is taken into account; and they have the opportunity to propose, modify, or reject rules related to water management in their communities. In general, we found that historically CAAR-high and ASADAS-high have had higher levels of participation of communities in decisionmaking processes.

Participation in early stages involved having a say on infrastructure and institutional design, including key elements, such as location of pipes and storage tanks, tariffs, water board composition, and electoral procedures, among other important features. This element, coupled with the existence of some property rights over land in water intake points, resulted in a strong sense of ownership.

Today, this sense of ownership is expressed in diverse forms: assembly attendance is high, there is a close oversight of water committee decisions,⁹ and participation in electoral processes is high. Besides this, all interviewed users revealed that they want to keep the current local institutional arrangement as opposed to governmental administration. The main reasons for this willingness to keep the actual governance structure are related to the positive perception of

⁹ More than 50% of interviewed users mentioned that they have had the opportunity to vote to approve or deny rule changes or plans proposed by the committee.

performance and high acceptance of decisions made by the water committee. (More than 60 percent of interviewed users approved of the committee's decisions in the last two years.)

4.6 Motivational Problems

The flipside of the coin is the tendency of local users in ASADAS-low and CAAR-low to free ride on the efforts of a few and the occasional governmental subsidy, and is exacerbated by the lack of enforceable rules. In ASADAS-low, all major investments in infrastructure construction and maintenance were possible due to external subsidies from different government agencies, thanks to the extraordinary political skills of the president of the water organization and his ability to exploit national electoral processes. It is also worth mentioning that the organization's recent transformation from CAAR to ASADAS was mainly due to the prohibition of ICAA officials from giving information and general support to any local organization that lacks delegation agreement. Because of this, the president and other committee members changed the formal structure of the organization in order to request new funds, even though they recognized that this transformation did not imply any significant modification in the working rules that governed the system.

The strong leadership exercised by the ASADAS-low president has substituted for the active participation of the rest of the community. This double dependence (on the president and on external funds) seems to create two perverse incentives that further increase dependency. First, it reduces the incentive to raise local funds. In fact, this organization has the highest delinquency rate among all organizations (>25 percent) and the lowest willingness to pay additional funds to cover infrastructure maintenance. Furthermore, when users were asked about a hypothetical situation in which the infrastructure must be replaced, only 44 percent answered that they would be willing to pay for the associated costs. (In CAAR-high and ASADASS-high, the answers were 67 percent and 80 percent, respectively.) Second, most users are passive observers, as evidenced by the low attendance rate at assemblies and less-frequent rotation of committee members.

A similar situation is also present in the CAAR-low organization. In this case, however, motivational problems are historical. A pioneer family built and maintained the infrastructure, and water was originally provided for free, based on family or friendship ties. Rapid population growth has created allocation problems, as well as threats to water quality from agricultural activities and infrastructure deterioration. There is strong opposition from users to set tariffs and regulate water consumption, and the original set of rules is completely inadequate to overcome these new challenges.

5. Conclusions

We explored how rural communities devise rules to solve their water provision problems, in light of the resource system, the socioeconomic characteristics of the local actors, and exogenously-defined governmental policies. We found that the most important mechanisms that can be linked to high performance are the result of the dynamic interaction of a set of working rules created by the local communities and properly defined local accountability, as well as the capacity of local leaders to generate appropriate incentives to involve the community in sustainable solutions for collective-action problems. In a recursive process, the combination of these attributes leads to a situation in which communities express a high sense of ownership and desire to assume the costs necessary to run the system properly.

One striking result is that the formal distinction among the four organizations studied does not seem to affect performance. On the contrary, what is actually important is the number and type of rules that are properly enforced and determined by the communities. The absence of these rules must explain why low-performing communities are incapable of solving collective-action problems adequately. Even though our inventory of working rules related to operational, collective choice, and constitutional activities, as well as accountability, have helped us discern why some communities perform well and others do not, more research is needed to fully understand how variations and different combinations of rules could affect outcomes in these settings.

Local accountability mechanisms are a particular subset of working rules that characterize effective governance structures. In particular, we found that this factor increases the likelihood that the desires of water users are reflected in the actions of the water committees. This result suggests that, in some settings, the most effective alternative to monitoring and sanctioning (or rewarding) the people directly responsible for the provision of water in the community is the local community, instead of external actors, such as the central government.

On the other hand, like similar studies in the literature (Isham and Kähkönen 2002; Kähkönen 1999; Sara and Katz 1998; Watson et al. 1997; Stalker 2005; Stalker et al. 2008), a demand-driven approach seems to be an important causal condition associated with high performance. The desire of communities to organize themselves to solve a pressing problem of water provision and their involvement in the design of infrastructure and institutions, as well as their willingness to pay for infrastructure construction and maintenance, are key to creating a sense of ownership that positively affects performance.

Contrary to the above discussion, we showed that there is a clear risk in assuming a paternalistic approach to water provision, even if it comes from within the communities.

Leadership that is too strong plus a high dependence on external funding can cause a motivational problem, where community members are passive observers and are not willing to commit time or money for needed maintenance and investments. In addition, dependency may increase if the central government finances the short-term provision of public goods without a realistic plan of maintenance and without an adequate sense of ownership by the recipients (Gibson et al. 2005; Ostrom, Schoeder, and Wynne 1993). In the long run, and despite external support and the best efforts of a few committee members, our results clearly indicate that lack of ownership and community motivation results in poor performance and under-provision of the public good.

Our results also have important implications in terms of the role of the central government in generating the enabling conditions that ultimately guarantee adequate provision of drinking water in rural areas. First, it is very difficult for a general governmental prescription that ignores the interests of those affected by the policy to generate appropriate incentives. Our evidence allows us to say that the transformation to a legal structure promoted by the central government does not necessarily generate the appropriate incentives for high performance. Furthermore, the low enforcement capacity of the government and the inadequate adaptation of formal rules to the peculiarities of communities explain why this policy blueprint is not an effective solution for local problems.

Given that performance is the result of a complex configuration of the resource system variables and its units, users' attributes, and the governance system, public policies that aim to increase performance must recognize this complexity in order to be effective. Second, governmental subsidies may create long-term financial dependence. Incentives that can crowd out local contributions and reduce the motivation for financial self-sufficiency must be carefully considered when supporting local organizations. Finally, we suggest that, in some circumstances, instead of subsidizing the infrastructure, the central government must support local communities by providing information and technical studies on delimitation of recharge areas and restoration of degraded ecosystems. Permanent and accessible training programs on the technical aspects of water infrastructure and management are also key elements for increasing local capacity to manage water systems over time.

We do recognize that it may be hard to draw general conclusions from only four cases, but our statistical approach to selecting the case studies attempts to isolate the governance dimension from the myriad of external elements that affect performance. As such, we expect our results to be externally valid with respect to similar rural aqueducts. As mentioned in the introduction, general recommendations for solving a water provision problem are doomed to failure, given the variability of underlying conditions. Instead of focusing on general recommendations (e.g.,

decentralization is good), we focused on the characteristics of governance and community dynamics that make a community organization successful in providing safe drinking water, which we believe have more general validity and applicability.

From the methodological point of view, the core conceptual variables listed, using the adapted SESs framework, represent our starting point in understanding the determinants of performance. Our qualitative analysis is a first step into determining which variables explain outcomes in drinking water community organizations. From this point, other research may want to test whether some of the mechanisms and variables identified are statistically significant for a broader population.

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