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How well is the demand-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru and Ghana

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Abstract

This paper reports the main findings of a multi-country research project designed to develop a better understanding of the performance of community-managed rural water supply systems in developing countries. Data were collected from households, village water committees, focus groups of village residents, system operators and key informants in 400 rural communities in Peru, Bolivia and Ghana. Our findings suggest that the demand-driven, community management model, coupled with access to spare parts and some technical expertise, has come a long way toward unraveling the puzzle of how best to design and implement rural water supply programs in developing countries. In all three countries, rural water supply projects were working. Among the households included in our sample in Peru and Bolivia, 95% had operational taps at the time of our field visit. In 90% of the villages in Ghana, all project handpumps were still working. Not only had the rural water systems not broken down, but almost all the households in these communities were obtaining at least some of their water from the systems. However, some households were also still using water from other sources. In Ghana, 38% of households still reported using water from unprotected sources (e.g. springs, river, open wells) for drinking and/or cooking. Another troublesome finding is that rural households in the sample villages are paying very little for the improved water services and, as a result, the finances of many village water committees are in poor shape.

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1. Introduction

This paper reports the main findings of a large, multi-country research project designed to develop a better understanding of the performance of rural water supply systems in developing countries. We initiated this research project in 2004 to investigate how the provision of support for communities after the construction of a rural water supply project affected its medium-term performance, defined as the period of system operation 3–12 years after initial construction. We collected information from households, village water committees, focus groups of village residents, system operators and key informants in 400 rural communities in Peru, Bolivia and Ghana. In total we discussed community water supply issues with approximately 10,000 individuals in these communities.

In the course of our investigation of the effects of post-construction support (PCS), we also learned much about how rural water supply systems are faring in parts of Peru, Bolivia and Ghana. We believe these observations will be of broad policy interest to professionals in the water sector because they contradict the general perception that most rural water systems fail and that success is dependent on cost recovery through sizeable, on-going user contributions. This paper summarizes these more general findings about the status of rural water projects, as well as our principal conclusions about the effects of PCS services on system performance[1].

In the next, second section of this paper we discuss the policy context for rural water supply programs in developing countries and summarize the conventional wisdom about how rural water supply programs should be designed and implemented to ensure their sustainability. The third section describes our research design and the fourth section the fieldwork conducted in Peru, Bolivia and Ghana. The fifth section presents our main findings regarding the status and performance of existing rural water projects and the factors associated with their success. In the sixth and final section we discuss some of the implications of our findings.

2. Background

In the 1980s it became widely recognized among sector professionals that many rural water supply programs in developing countries were performing poorly (Churchill *et al.*, 1987; Therkildsen, 1988; Briscoe & DeFerranti, 1988). Regardless of the type of technology utilized, systems were not being repaired and were falling into disuse. Cost recovery was minimal and revenues were often insufficient to pay for even operation and maintenance, much less capital costs. Communities did not have a sense of ownership in their water projects and households were not satisfied with the projects that donors and national governments installed.

An intensive discussion ensued within the water resources profession about the reasons why success in the rural water supply sector was so difficult to achieve. Engineers blamed poor quality construction,

[1] The more detailed results about the effects of post-construction technical assistance can be found in our papers and reports on Ghana, Bolivia and Peru (Komives *et al.*, 2007; Thorsten, 2007; Davis *et al.*, 2008; Prokopy *et al.*, 2008).

anthropologists described a lack of community participation, political scientists reported rent-seeking and poor governance structures and economists complained of poor pricing and tariff design. In the 1990s a consensus emerged that pre-project planning procedures for rural water supply programs needed to be more "demand-driven". The necessary components of a demand-driven process differ somewhat depending on who one asks, but most would agree that project planning should (1) involve households in the choice of both technology and institutional and governance arrangements, (2) give women a larger role in decision-making than has historically been the norm and (3) require households to pay all of the operation and maintenance costs of providing water services and at least some of the capital costs (Sara *et al.*, 1996; Sara & Katz, 1997; Whittington *et al.*, 1998).

The rationale for involving households in the choice of technology was to ensure that engineering designs were responsive to local needs and realities. Women should assume a greater role in decision-making because they were the ones who best knew these local realities and were primary beneficiaries of the projects. Cost recovery through user fees served three purposes. First, it required households to pay for services once operational, provided revenues to keep the system running and reduced dependence on higher-levels of government. Second, charging households (part of) the capital cost of system construction prior to installing the water supply system established a "demand filter" that theoretically prevented water systems from being built in communities where they were low-priority development projects. Third, requiring capital contributions by communities was expected to foster a sense of community ownership of the facilities, which in turn was expected to solidify a commitment to use and maintain the facilities.

This consensus on the necessary components of a demand-driven planning model was largely silent on the relative importance of these components. Were all three components of the model necessary for success? Or were two out of three sufficient? Was it possible to proceed in a sequential fashion, implementing some parts of this planning model first and following up with others at a later date? There was an implicit assumption that, if other elements of the demand-driven planning model were present and spare parts were available for purchase, communities would be prepared to assume responsibility for the management and maintenance of their water systems without further post-construction support (PCS).

The most controversial component of the policy advice in the demand-driven, community management model has been to require that households pay a share of the capital costs and all of the operation and maintenance costs of providing rural water services. In many cases rural households without improved water sources are the very poorest and efforts to require such households to pay something for services (or to target investments at communities that are collectively willing and able to pay) have often disturbed both large multilateral donors and small non-governmental organizations (NGOs) working in the sector. Small NGOs, such as church-based organizations and other charities, especially want to help poor people in direct, tangible ways. Projects to provide improved water supplies for poor rural households have often received strong support from both NGO staff and their donor base and the argument that people should have to pay for such services has seemed antithetical to the rationale and desire of many NGOs to be involved with such communities in the first place.

Objections to charging poor rural households for improved water systems arise not only from a belief that rich countries and individuals have a moral obligation to transfer financial resources to poor households in order to eliminate global inequities. Analysts have also argued that the provision of improved water services has large positive health externalities and thus a traditional economic efficiency criterion calls for the use of a Pigouvian subsidy to equate marginal social benefits with marginal social costs[2].

A somewhat different line of argument in support of providing improved water services free of charge is that poor households are caught in a vicious cycle of poor health, limited education and low economic productivity and that improved water (and sanitation) services are one change that helps people to break out of this “poverty trap” (Sachs, 2005). From this perspective, subsidized rural water projects are not only equitable and morally obligatory, but they are also engines of economic growth. This argument for *simultaneously* investing the health, education and infrastructure is exemplified by the desire to meet the multisectoral Millennium Development Goals by 2015[3]. Although there is no rigorous empirical evidence that investments in water supply projects cause (or induce) economic growth in poor rural communities, the “poverty trap” metaphor resonates strongly with NGOs and other donors uncomfortable with the cost recovery component of the demand-driven, community management model[4].

NGOs and multilateral donors have been less reluctant to shift non-pecuniary costs (such as time and labor commitments) onto community members. The demand-driven, community management model holds that much of the human resource costs of managing rural water projects should be transferred to village water committees (VWCs). This proposal has been relatively uncontroversial.

Since the mid-1990s a number of donors, working with national and regional water resources ministries in developing countries, have designed and implemented rural water supply programs that incorporated one or more components of this demand-driven, community management model. Few of these programs planned for systematic provision of PCS; community management was assumed to be feasible from a technical perspective. Recently some have argued that it is unrealistic to expect that government can leave rural communities to their own devices after a water project is completed and that for rural water supply systems to be successful, communities need some PCS, such as follow-up training and technical assistance visits by engineers (Kleemeier, 2000; Lockwood, 2002, 2003).

There is little systematic evidence about how the demand-driven, community management model (with or without PCS) is working in practice. Are the projects implemented using the demand-driven, community management approach successful? Are the systems working? Are village water committees able to have systems fixed when they break? Do the committees function as planned? Are revenues being collected? Are households satisfied with rural water supply projects? These are some of the questions we address in this paper. Although the conventional wisdom in the water resources community still seems to be that the rural water supply sector is prone to failure, much of the policy discussion remains focused on how to increase donor support to expand rural water supply coverage (UNDP, 2006).

3. Research design

It is important to understand our initial research design in order to appreciate the strengths and limitations of the findings presented in this paper. We wanted to investigate the effect of PCS on system

[2] The empirical evidence for the existence of such positive externalities from improved water supplies is, however, surprisingly limited. See Fewtrell *et al.* (2005) for a recent review of the effect of improved water, sanitation, and hygiene interventions on health.

[3] See www.un.org/millenniumgoals.

[4] This advice about the need for *simultaneous* investments across sectors has never been widely accepted by economists. See, for example, Schumpeter (1939) and Hirschman (1958).

sustainability when added to a well-designed demand-driven, community management rural water supply program[5]. A gold standard research design would consist of a randomized controlled experiment in which baseline conditions would be measured in villages, all of which had received an improved water system as part of such a well-designed rural water supply program (Baker, 2000). Subsequently PCS would be randomly assigned to treatment villages but not to control villages and then any differences in treatment and control villages could be confidently attributed to the PCS intervention.

We did not have the time or resources to assign PCS to treatment and control villages randomly and then collect data on system performance before and after the treatment intervention[6]. The best we could do was to try to find situations where some villages had received PCS and other similar villages had not. In order to establish the direction of causation between PCS and system performance, we needed to find well-designed demand driven programs in which some villages had received PCS "automatically" (i.e. the treatment villages) and other villages had not (the control villages). In other words, we needed a situation in which the treatment villages received PCS services *without asking for them*. Otherwise, one could easily suspect that the treatment villages that demanded the PCS services (i.e. called in or sought out PCS services) would be systematically different from the control villages.

In the design of the research project, we searched for rural water supply programs in developing countries around the world that used a "state of the art" demand-driven, community management model, but also used a "supply-driven" (automatic) PCS program to assist villages after construction. Demand-driven, community managed rural water supply programs that have been in operation for several years are not all that common; such programs with "supply-driven" PCS components are rare around the world. We selected programs in Bolivia, Peru and Ghana that we believed came closest to meeting these research design criteria.

In all three countries we included in our sample villages that had received improved water supply projects 3–12 years earlier as part of a demand-driven, community managed, donor-supported rural water supply program. Approximately half of the villages in the sample were treatment villages and half were controls. In all three countries we used secondary data to attempt to choose districts or regions where the characteristics of villages and households in the treatment and control villages were likely to be similar.

In Bolivia both the treatment and control villages were part of PROSABAR (Proyecto de Saneamiento Básico Rural), a World Bank-funded program that grew out of a water and sanitation program pilot project implemented in the *departamento* of Potosí. We selected 99 PROSABAR villages in the Chuquisaca and Cochabamba *departamentos*. Sample villages were located in the central highlands at elevations of 1,800–3,000 m; rainfall varied from 30–69 cm per year.

Within each *departamento*, we tried to include approximately 25 communities that had received some form of PCS and another 25 that had not. However, the determination of "treatment" and "control"

[5] It did not seem interesting to study the effect of PCS in poorly designed programs because there is ample evidence in the literature (e.g. Narayan-Parker, 1995; Sara & Katz, 1997) that these programs would have many failures and that PCS alone could not salvage them.

[6] Nor did we have the time or resources to measure baseline conditions in treatment and control villages and then wait for the effects of the treatment (PCS) to unfold. Rather, we collected information from both treatment and control villages in the current period, after some villages had received PCS. We were thus forced to ask people we interviewed today about conditions in the past, both before and after their rural water system was constructed. This approach is not ideal, because people's memories are imperfect and some baseline data simply were not available to us.

communities was problematic because the municipal records regarding the provision of PCS were often incorrect. Communities were later reclassified into the "treatment" or "control" group based on interviews, reports and records related to PCS in each community. Across both *departamentos*, 34% of the sample communities received some sort of PCS and 66% did not. The percentages varied for specific types of support and by *departamento*, as discussed further below.

In Peru both treatment and control villages were located in the Cuzco region. The 43 treatment villages were part of the Swiss-funded SANBASUR project; the 56 control villages were from the World Bank-financed FONCODES project. As in Bolivia, the sample villages in Peru were in the central highlands. Elevations of villages were slightly higher than in Peru (2,500–4,000 m); annual rainfall was about 70 cm. The average village size in Peru (588 people) was a third smaller than in Bolivia (870 people).

In both Bolivia and Peru the rural water systems, installed as part of the programs, were almost all gravity-fed piped distribution systems with unmetered private connections. In some villages there were a few public taps for unconnected households. These systems were, on average, seven years old at the time of the fieldwork. Capital costs in Bolivia were approximately US$80 per capita at the time of construction (US$400 for an average household with five members); costs in Peru were probably comparable[7].

In Ghana the treatment villages were selected from four districts in the Volta region and the control villages from five districts in the Brong Ahafo region. The Ghana Community Water and Sanitation Agency implemented the rural water supply programs in both regions. The treatment villages in Volta were part of a Danida-funded program, which since 2003 included a PCS component called "monitoring of operations and maintenance" (MOM); the control villages in Brong Ahafo were part of a World Bank-funded rural water supply program. Both treatment and control villages were in lowland forests at elevations of 74–503 m. Annual rainfall was about 120 cm. The average age of the water systems in Ghana was six years.

In Ghana, only villages with boreholes and non-mechanized public handpumps were included in the sample. The results of recent contract awards in Brong Ahafo and Volta indicate that the total cost of drilling a successful borehole and installing a handpump is typically in the range of US$10,000–12,000. The sample of both control and treatment villages was limited to communities that received no more than two boreholes as part of the water supply program. This effectively also limited the size of the villages; at the time of our field visits in 2005 the population of sample villages ranged from 200 to 5,000 people. These selection criteria yielded a potential sample frame of 98 villages in the Volta region and 120 villages in the Brong Ahafo region. All 98 villages in the Volta region were selected and 104 of the 120 villages in the Brong Ahafo region were randomly selected.

Field conditions in Bolivia, Peru and Ghana presented us with some unanticipated challenges. Our research design required that the water system in some villages be "successes" and in others "failures" in order to have variation in our dependent variable. In fact, as described below, we found far fewer project failures in either treatment or control villages than expected.

The complexity of PCS provision in the study settings posed another threat to our research design. To establish the direction of causation between PCS and system performance, we tried to identify PCS programs that were "supply-driven", but in reality even supply-driven PCS programs often do not work that way in practice. The Danida-funded MOM program in Ghana turned out to be the only true supply-driven PCS program in our three study sites: villages in this program received quarterly visits from

[7] We were unable to collect data on capital costs on the systems in Peru during the fieldwork.

environmental health assistants to monitor the technical, management and financial status of the rural water supply systems. It was more common to find cases of communities seeking out PCS when their water systems broke or when there was a management problem or conflict (i.e. "solicited" PCS)[8]. We also found that help is often available to communities from more than just one "official" source. If a village water committee cannot find assistance in one place, there are often other places to turn to for help, such as NGOs, nearby municipalities, or large commercial enterprises. Some villages may have the political clout to obtain financial assistance from a member of Parliament or a wealthy relative of a village resident living abroad. Thus, even in PCS programs designed to be supply-driven, in practice much PCS is demand-driven in the sense that many communities seek out help from wherever they can get it.

One implication of this complexity of PCS provision is that many control villages in our study sites had various demand-driven forms of PCS available to them. Especially with the public handpump technology used in Ghana, breakdowns are to be expected and thus repairs are necessary. Control villages (without supply-driven PCS) must be able to obtain spare parts and mobilize the technical expertise necessary to make repairs. Without these, *all* handpumps in villages in a rural water supply program (and some gravity-fed distribution systems as well) will have broken down after only a few years. Our research question was whether PCS services (both technical and non-technical) from higher levels of government would lead to better performance of the village water system, although the baseline conditions in the control villages was never no PCS at all. The control villages in any well-designed demand-driven, community managed rural water supply program, at least initially, also have access to spare parts and to some technical expertise (although for a variety of reasons control villages might not retain or mobilize for use the training or procurement systems put in place at the time of project construction).

In summary, the implementation of our initial research design revealed the complexity of unraveling the causation relationship between PCS and system performance. It also led us to study donor-funded rural water supply projects and thus communities that were not randomly selected from either a global or country perspective.

4. Data collection and profile of sample villages

Fieldwork began in Peru in the summer of 2004, in Ghana in the autumn of 2004 and in Bolivia in early 2005. Data collection activities in each country were similar but not exactly the same. Generally a data collection team spent one day conducting the fieldwork in a village. During the course of the day, the team held a group interview with members of the village water committee, interviewed the water system operator or caretaker (and borehole attendant if applicable), conducted a focus group with women from a diverse set of backgrounds, ages, ethnic and income groups and administered surveys to the heads of household (or spouse) in approximately 25 households. In Bolivia we worked with leaders to draw community maps and drew random samples of households. In Peru and Ghana, enumerators were scattered more or less throughout a village and instructed to interview every fifth household or some other similar sampling rule. In Bolivia and Peru, interviews were conducted in either Spanish or

[8] Given the choice of sending technical personnel to a community that has requested assistance and another community that is due for a regularly scheduled "check up" visit, but is presumed to be doing fine, it is natural for a manager of a "supply-driven" PCS program to be inclined to direct resources to where the problem is.

Quechua; in Ghana in either Twi or Ewe. In addition to the survey and focus group information collected by the fieldwork teams, technical staff made an engineering assessment of the water supply system in each village in the three countries. In Peru and Ghana, data collection also included a focus group discussion with village leaders. In Ghana, the most heavily used borehole in the village was observed for one day and data were collected on the quantity of water obtained. Most of the information presented in this paper comes from interviews with village water committee members, water system operators and households.

This information showed that the sample villages in Bolivia and Peru were small and remote; in Ghana they were on average larger and more accessible. The majority of villages in Peru and Bolivia had electricity and many households were connected to this service. In Ghana only 32% of the sample villages were connected to the electricity grid. In all three countries the majority of households reported that they were farmers. Average education levels were low; the typical respondent in all three countries reported having "some" primary education. In Peru, 60% of the households interviewed reported annual cash income of less than US$150 (vs. 42% in Bolivia). In Ghana, households reported median monthly expenditures of about US$57. The average household had five members in Peru and Bolivia (vs. 6 in Ghana). High percentages of households in Bolivia (86%) and Ghana (75%) reported trusting their neighbors (vs. 51% in Peru).

5. Results

5.1. Communities were involved in the pre-construction planning

Our interviews showed that community members felt that they had been involved in the pre-construction planning of their water system. In all three countries over 90% of focus groups held with village leaders and/or women reported that the community had been involved in tariff design. In approximately two-thirds of the villages in Bolivia and Peru, people felt they had been involved in the choice of technology (vs. 42% in Ghana). In slightly less than half of the villages in all three countries, people felt involved in decisions about the site of projects (location of distribution lines in Peru and Bolivia, handpumps in Ghana). In all three countries communities contributed 5–10% of the capital costs of the project, but in many cases labor and/or land contributions were allowed to substitute for cash. Overall our results confirm that many of the desired preconstruction elements of the demand-driven, community management model were implemented in both treatment and control villages in all three countries.

5.2. Community water supply projects are still working

Based on our reading of the literature (Edig *et al.*, 2002; Engel *et al.*, 2003) and discussions with sector professionals familiar with the local situation in all three countries, we expected to find a substantial minority—or perhaps even a majority—of the water systems in the villages in our sample to be performing poorly or broken down, but this was not the case. In all three countries, in both treatment and control villages the rural water supply projects were "working". How one defines the performance of rural water projects is somewhat more complicated than one might imagine, but in our case the definition used did not affect our conclusion. As shown in Table 1, all the piped systems in Peru, and all but one of the systems in Bolivia, were functioning at the time of our field visit. Among the households included in

Table 1. Profile of village water systems and management practices.

	Bolivia*	Peru	Ghana
Description of the system			
Average years since project completion	7	7	6
Percentage of villages—private connections only	73	100	0
Percentage of villages—public taps only	4	0	100
Percentage of villages—private connections and public taps	23	0	0
Percentage of villages with only one project handpump	N/A	N/A	50
Status of the system			
Percentage of households with functioning taps	95	95	N/A
Percentage of villages with all taps functioning	54	74	N/A
Percentage of villages where all project handpumps are working	N/A	N/A	89
Percentage of villages with functioning systems, which had reported a breakdown over last six months	55	55	57
Average days to repair the system (for villages that had experienced a breakdown)	1–2	5	18
Management structure			
Percentage of villages where committees regularly hold meetings with the community	86	81	72
Percentage of villages where committee members are elected	95	63	42
Percentage of villages where committee members are appointed	3	15	43
Median number of women on the committee	0	0	3
Percentage of villages with no caretaker/operator	3	2	18
Percentage of villages with paid caretaker/operator (in villages with a caretaker)	70	57	1
Cost recovery			
Cost recovery mechanisms			
Pay-by-the bucket or volumetric tariff	2	0	39
Fixed monthly fee	89	82	54
Fees vary by household size	0	0	7
Irregular collections	0	7	16
No revenue collection	9	11	13
Percentage of households in full sample who use the system that reported paying for water	87	77	71
Median monthly expenditure for water reported among households that pay for water (US$)	0.55	0.30	N/A
Percentage of committees reporting that household collections cover operating costs	N/A	50	51
Percentage of committees reporting that household collections cover minor repairs	N/A	80	65
Percentage of committees reporting that household collections cover major repairs	N/A	12	30

*88% of systems in Bolivia were gravity only; the others used pumps.

our sample in Peru and Bolivia, 95% had operational taps at the time of our field visit. In 55% of the communities in Bolivia and 76% in Peru, 100% of the household taps were operational. In 90% of the villages in Ghana, all project boreholes were still working.

This finding holds very good news for the rural water sector. The demand-driven, community management model seems to be working, at least in the medium term. Not only were the rural water systems producing water (i.e. had not broken down), but almost all the households in these communities were obtaining at least some of their water from the systems. In Bolivia, 100% of the households interviewed reported using water from the improved water system; in Peru it was 95% and in Ghana 97%. In Ghana, our estimates of the amount of water collected by households from boreholes ranged from 34 liters per day in Volta to 24 liters per day in Brong Ahafo. These levels of per capita water use are quite high for rural areas of Africa when people carry water from a source outside their home (White *et al.*, 1972; Mu *et al.*, 1990; Katui-Kafui, 2002) and indicate that these borehole projects have succeeded in terms of supplying relatively large quantities of water for household use.

In all three countries, the vast majority of VWCs are functioning as planned. They hold regular meetings. Many of the VWC members were elected and, in Ghana, many of these were women (Table 1)[9]. In Bolivia and Peru every community had a system operator who was responsible for the operation and maintenance of the water system. In Ghana, 82% of the communities still had a caretaker for the handpump(s). The systems in all three countries do occasionally break down, but in the majority of cases the VWCs are able to arrange for repairs. The majority of villages in all three counties reported one or more breakdowns in the last six months, but in Bolivia this was typically fixed in 1–2 days. In Peru, breakdowns were fixed on average in five days and in Ghana in 18 days[10].

In Ghana most villages in the sample had functioning VWCs: only 3% of VWCs in the study villages in Volta and 7% in Brong Ahafo had been disbanded or relieved of their duties. Another 5% of VWCs were inactive or dormant. There are a variety of different explanations for these instances of VWC failure or inactivity. In some cases the committee had stopped work owing to conflicts with the community or village leaders (usually over revenue collection, the use of collected revenues, or unsuccessful repairs). In others, the committee was dormant because there was "no work to do" (the borehole had either not broken down or had not functioned in a long time). In a few villages another village-level institution had assumed the responsibility for the water system.

In all three countries the water systems were working, communities were able to make repairs and as a result, levels of household satisfaction were very high in most villages. On average, in Bolivia, 83% of households in each village reported being "satisfied" or "very satisfied" with their system's operation and maintenance (O&M) regime and 78% with the performance of their VWC. In Peru, 61% of households reported that they were satisfied overall with the improved water system. In Ghana, 88% of households interviewed reported that they were satisfied with the repair and maintenance services of their water system and over 80% of the women's focus groups said they were satisfied with the systems[11].

5.3. Households still using unprotected sources

But there are also some troubling findings. Although almost all households reported using the new water system, for some households this was not their only water source. Especially in Ghana, 38% of households still reported using water from unprotected sources (e.g. springs, river, open wells) for drinking and/or cooking. The number of households using unprotected sources for these purposes was

[9] This does not necessarily mean that the women are active committee members (see evidence from India in Prokopy, 2004).
[10] The main reason that repairs take longer in Ghana is that parts for boreholes must be obtained from outside the villages. In Bolivia and Peru many of the repairs can be made with parts that communities have on hand.
[11] Dissatisfaction in Ghana was primarily concentrated in villages where the handpumps were no longer working or had always had problems (e.g. salty water or low pressure in the dry season).

lower in Peru (21%) and Bolivia (23%), but still worrying. We do not have information on the health consequences for the substantial minorities of the population in our sample villages which continue to use traditional water sources, but we speculate that until households obtain their drinking and cooking water exclusively from improved sources, the health benefits of the investments in improved sources will not be fully realized and any prospects for breaking out of a rural "poverty trap" will be reduced.

5.4. Households pay little for improved services

Another worrying finding is that rural households in the sample villages are paying very little for the improved water services and, as a result, the finances of many VWCs are in poor shape. As noted, these rural water supply programs were not designed for communities to recover the capital costs of construction or to provide for capital replacement or expansion. The cost recovery objective was simply to collect sufficient revenues from users on an ongoing basis to pay operation and maintenance costs. But a substantial minority of villages in our study is not achieving even this modest objective.

In both Bolivia and Peru almost all villages charged households a very modest fixed monthly fee for service. In Bolivia 87% of households and 77% of households in Peru reported paying for water, but the median monthly expenditures were only US$0.25 and $0.66, respectively. In Bolivia the monthly charges were not only low, but 27% of communities had actually lowered their tariffs since operation began. In Peru, we estimate that slightly less than half of the communities manage to recover their operating costs.

In Ghana, 13% of VWCs say that they do not collect any money from households. When we asked households (in contrast to VWC members), in 23% of the villages we found no households interviewed that reported paying for water. Only 71% of the villages in Ghana have any regular payment system for households (either pay-by-the bucket or fixed monthly charge, as opposed to an irregular system like collecting money from households when funds are needed for repairs). In villages that used fixed monthly fees, the most common rates were US$0.11 and US$0.22 per month. In villages using pay-by-the-bucket, the most common charges per 20-liter container were US$0.01 or less.

Among the VWCs in Ghana that did collect revenue from households, those in Volta reported collecting an average of US$169 annually from households (versus US$173 in Brong Ahafo). Revenues of this magnitude should be sufficient to pay for routine operations and maintenance, but not major repairs[12]. However, the range of revenue collections reported by these VWCs was very wide, with some committees saying they collected less than US$1 from all households during the entire year and others reporting household contributions above US$2000. Nearly three-quarters of the VWCs in Ghana that reported charging households for water (regular or irregular payment system) felt that they collected enough money to pay for the cost of operations. Eighty nine percent said that they could pay for minor repairs with the money collected from households, but only 41% of the VWCs that were charging households for water said that they could pay for major repairs.

[12] A 1994 study of the Afridev handpump in Ghana's northern region found that the average annual cost to a community of fixing common problems, such as rod breakages, plus the cost of replacing fast-wearing parts like bobbins, U-seals, O-rings and bearings, would be about US$60 (Osafo-Yeboah, 1994). UNDEP's International Environmental Technology Centre (2009) puts the expected operation and maintenance cost for communities with handpumps serving 200 to 300 people at between $0.26 to $0.52 per capita per year. VWCs in our sample reported spending about US$100 annually on repairs. None of these estimates include the real resource costs associated with the time invested by the VDC, the caretakers, or borehole attendants.

5.5. Villages use post-construction support

Despite the problems many communities have charging in households for water services, the majority of communities in all three countries are managing to keep their improved water systems functioning. Even communities that are not collecting sufficient revenues to pay for operation and maintenance costs are finding the resources they need to fix their systems when they break. Especially in Ghana, many of these resources come from outside the community (Table 2).

Nearly half of the communities in all three countries have received additional training for their water system operators or caretakers since construction. Some villages have received help with non-technical matters, such as billing or disputes over water sources. When water systems break, system operators seek out spare parts and, if necessary, outside technical expertise to make repairs. Few VWCs keep sufficient cash on hand to pay for major repairs. Nonetheless, they seem able to find the funds for repairs somewhere, be it through one-time special assessments of villagers, through grants from outsiders, or in the form of free parts or repair services. In some cases, the caretakers or VWCs turn to "middle men" to help identify and obtain the resources they need. In Ghana, for example, the District Water and Sanitation Teams (DWST) and the environmental health assistants involved in the MOM program have helped communities find technical assistance and spare parts. But other actors help as well. One of the striking findings from our field activities was the pervasive presence of NGOs and church organizations in PCS activities.

Many NGOs are providing both supply-driven *and* demand-driven PCS. In Bolivia, NGOs like Plan International and CARE have taken on increasingly programmatic roles in the rural water sector in the sample villages as the role of government has diminished. In recent years they have largely assumed responsibility for PCS. In Peru the "prime contractor" NGO (Sanbasur) assisted communities in filling the gap between the revenues raised and funds needed for repairs by putting such communities in touch with other partner NGOs or with municipal governments who could provide financial and other assistance. In Ghana, fully 16% of the sample villages have received grants for repairs and/or major rehabilitation from outside sources such as the Church of the Latter Day Saints (Table 2). The Mormons and perhaps other NGOs appear to have worked with the DWSTs to identify villages that are experiencing problems and then to help finance the repairs. The DWSTs not only lack funds to monitor conditions proactively in villages, but also are instructed by policy guidelines not to make or fund repairs themselves.

Table 2. Profile of PCS activities.

Percentage of villages that received .... after completion of project construction	Ghana (%)	Peru (%)	Bolivia (%)
Visits from external organization(s) to assist with maintenance or repairs	52	14	22
Visits from external organization(s) to assist with accounting, tariffs, etc.	33	6	13
Technical training for the system operator	34	49	41
Free repairs	21	N/A	N/A
Written manuals or other materials	37	25	30
Help with finding or receiving spare parts	45	7	11
Grants from outside sources for repairs, new construction, system rehabilitation, capacity expansion, or other assistance	16	3	8
Percentage of households visited by external agencies to discuss use of water system, etc.	30	25	N/A

5.6. Factors are associated with sustainability and satisfaction

Communities are making use of a wide-variety of government- and NGO-provided PCS services to keep their systems working, some of which are provided at their request ("solicited PCS") and others ("supply-driven") at the initiative of government or NGO or church organizations. Our cross-sectional research design and the character of PCS in the three countries make it very difficult to draw definitive conclusions about the contribution of different forms of PCS to system sustainability. Nonetheless, we used multivariate models to investigate the factors (including PCS) that were associated with whether or not the village's improved water systems were working and whether households were satisfied with the service they received.

For our analysis of technical sustainability, we explored a variety of definitions of our dependent variable. The one we choose to report for Bolivia and Peru is simply whether or not 100% of the household connections were functioning in the village at the time of our visit. For Ghana, our dependent variable is whether or not all the project handpumps and boreholes were operational (supplying water) at the time of our visit. Table 3 presents the means, medians and standard deviations of our independent variables. Table 4 reports the results of the model for each of the three countries.

Some of the factors positively associated with good system performance are as expected. In Bolivia and Ghana (but not in Peru) electricity coverage was positively associated with good system performance, which we think is likely to be a wealth effect. In Peru the age of the water system was negatively correlated with system performance (statistically significant at the 1% level), but this may be because the sample of communities in Peru included some water systems that were completed more recently than in Peru or Ghana. There is no association between age and system performance in Bolivia or Ghana—which we interpret as further evidence that the demand-driven, community management model is working as hoped in the medium-term.

In none of the three countries was there a statistically significant association between a village receiving a technical PCS visit (to help with repairs or maintenance) and having a working water system. Post-construction technical training of system operators or caretakers was, however, positively associated with system performance in both Ghana and Bolivia.

In Bolivia, water systems in the Chuquisaca region were more likely to be working than in the Cochabamba region. In Peru, projects in the SANBASUR program were more likely to be working than those in the FONCODES program. In Ghana, there was no statistically significant association between region (Brong Ahafo vs. Volta) and system performance. This finding suggests that a labor-intensive supply-driven PCS program like MOM (quarterly audits of the technical and financial function of the water supply systems by environmental health assistants) does not increase the technical sustainability of handpump systems in a setting like rural Ghana where communities have access (if requested) to many others forms of PCS[13].

Because the technology in Ghana (handpumps) was different from that in Bolivia and Peru (gravity-fed systems with household connections), the Ghana model has three independent variables not included in the Bolivia and Peru models: (1) whether the village had only one borehole, (2) population per borehole and (3) whether the village had an unprotected source that always has water during the dry

[13] We did not investigate whether the MOM program improved hygiene, water use habits, or cleanliness of the handpump sites, all of which would be other expected benefits of regular visits by environmental health assistants.

Table 3. Summary statistics (mean and standard deviation) of variables used in the multivariate models.

Variable name	Variable definition	Bolivia ($n = 77$)	Peru ($n = 99$)	Ghana ($n = 175$)
Satisfaction	% of households who report being satisfied with: Maintenance and operations of piped water system (Bolivia) Maintenance and repair (Peru) Preventative maintenance and repair service (Ghana)	Mean: 83 Std. dev: 20 Median: 90	Mean: 70 Std. dev: 19 Median: 72	Mean: 0.87 Std dev: 0.15 Median: 0.92
System working	1 = All sampled taps in the village are functioning (Bolivia and Peru) 1 = All project handpumps in the village are functioning	Mean: 0.59 Std. dev.: 0.50 Median: 1	Mean: 0.75 Std. dev: 0.44 Median:1	Mean: 0.90 Std. Dev: 0.30 Median:1
System age	Number of years since system began operation (Bolivia and Peru) Number of years since handpumps were installed (Ghana)	Mean: 7.0 Std. dev.: 1.2 Median: 7.0	Mean: 6.7 Median: 7.0 Std. dev: 2.3	Mean: 6.0 Median: 6 Std. dev: 0.8
Number of handpumps	1 = village received only one hand pump (Ghana)	N/A	N/A	Mean: 0.51 Std. dev: 0.50 Median: 1
Population per handpump	Population per handpump installed by project (100s of persons)	N/A	N/A	Mean: 6.43 Std. dev: 6.38 Median: 4.32
Electricity coverage	Percentage of households interviewed with electricity	Mean: 39.0 Std. dev.: 41.2 Median: 14.5	Mean: 60.5 Std. dev: 39.5 Median: 80	Mean: 13.69 Std. dev: 23.49 Median: 0
Remoteness	Distance in kilometers to: . . .municipality (Bolivia) . . .paved road (Peru) . . .area mechanic (Ghana)	Mean: 44 Std. dev.: 57 Median: 24	Mean: 58 Std. dev: 85 Median: 15	Mean: 19 Std. dev: 18 Median: 15
Trust of neighbors	Percentage of households interviewed who say they trust their neighbors	Mean: 83 Std. dev.: 18 Median: 88	Mean: 56 Std. dev: 18 Median: 56	Mean: 74 Std. dev: 14 Median: 76
Reliable unprotected alternative source	Village has unprotected source that always has water during the dry season within 1 km of the village	N/A	N/A	Mean: 0.21 Std. dev: 0.41 Median:0

Continued

Table 3. *Continued*

Variable name	Variable definition	Bolivia ($n = 77$)	Peru ($n = 99$)	Ghana ($n = 175$)
Technical training	1 = During the post-construction period, water system operator or village caretaker has received technical training	Mean: 0.28 Std. dev.: 0.45 Median: 0	Mean: 0.36 Std. dev: 0.48 Median: 0	Mean: 0.39 Std. dev: 0.49 Median: 0
Technical PCS visit	1 = During the post-construction period: ...received ≥ 1 unsolicited technically-oriented visit (Bolivia) ...received ≥ 1 unsolicited visit to assist with repairs (Peru) ...received ≥ 1 unsolicited free repair (Ghana)	Mean: 0.20 Std. dev.: 0.40 Median: 0	Mean: 0.07 Std. dev: 0.26 Median: 0	Mean: 0.19 Std dev: 0.36 Median: 0
Financial or managerial PCS visit	1 = During the post-construction period: ...received ≥ 1 unsolicited non-technically oriented visit (Bolivia) ...received ≥ 1visit to assist with financial or management matters (Ghana)*	Mean: 0.10 Std. dev.: 0.30 Median: 0	Mean: 0.04 Std. dev: 0.2 Median: 0	Mean: 0.29 Std. dev: 0.46 Median: 0
Regional or project identifiers	Bolivia: 1 = Cochabamba region 0 = Chuquisaca region Peru: 1 = SANBASUR program 0 = FONCODES program Ghana: 1 = Volta region 0 = Brong Ahafo region	Mean: 0.50 Std. dev.: 0.50 Median: 0.50	Mean: 0.45 Std. dev: 0.5 Median: 0	Mean: 0.48 Std. dev: 0.50 Median: 0

* Theoretically all villages in Volta should have received assistance with financial and managerial matters through the MOM program, but not all VWCs perceived the MOM audits as such.

Table 4. Factors associated with "system working".

	Bolivia	Peru	Ghana
Dependent variable	Household taps functioning (1 = 100% working, 0 = otherwise)	Household taps functioning (1 = 100% working, 0 = otherwise)	All project boreholes in the village are working
Remoteness	β: 0.01 (SE: 0.01) *Odds ratio: 1.01*	β: 0.00 (SE: 0.003) *Odds ratio: 1.00*	β: 0.01 (SE: 0.016) *Odds ratio: 1.01*
Electricity coverage	0.03* (0.01) *1.03*	0.013 (0.009) *1.01*	$0.08^{\dagger}$ (0.035) *1.09*
Technical PCS visit	0.17 (0.83) *1.19*	1.172 (1.226) *3.23*	−1.16 (0.82) *0.31*
Financial or managerial PCS visit	0.43 (1.11) *1.54*	−1.047 (1.661) *0.35*	−0.04 (0.86) *0.96*
Technical training	1.16‡ (0.69) *3.19*	−0.390 (0.595) *0.68*	1.48† (0.71) *4.43*
System age	−0.42 (0.27) *0.66*	−0.346* (0.147) *0.71*	0.46 (0.49) *1.58*
Trust of neighbors	−0.04 (0.02) *0.96*	1.368 (2.038) *3.93*	0.04 (0.03) *1.03*
Region or program dummy variable	$-2.91^{\dagger}$ (0.97) *0.05*	$1.38^{\ddagger}$ (0.78) *3.99*	0.77 (0.79) *2.16*
One borehole			1.99* (0.75) *7.31*
Population per borehole			$-0.091^{\dagger}$ (0.037) *0.91*
Reliable alternative source			−1.98* (0.70) *0.14*
Intercept	$7.88^{\dagger}$ (3.23)	1.63 (2.11)	−4.04 (4.11)
Pseudo R^2 value	*0.23*	*0.14*	*0.30*
Number of observations	*77*	*86*	*175*

* Significant at 0.01 level.
† Significant at 0.05 level.
‡ Significant at 0.10 level.

season within 1 km of the village. All three were statistically significant factors associated with system performance.

If a village had only one borehole, it was more likely to be working. We interpret this to mean that the VWC makes more effort (and is under more community pressure) to keep the borehole working if there is only one in the village. We interpret population per borehole as a measure of the pressure on the resource and a measure of crowding. It is negatively associated with system performance, which we speculate means that more intensive use of boreholes in these communities leads to the need for more difficult and expensive repairs, or that households value the handpump less when it must be shared with more households and thus put less pressure on the VWC to keep it working. Our interpretation of the negative association between having a reliable alternative source and a functioning water system is similar—households have less need for the improved water source when there is a reliable alternative source nearby, value the new source less and put less pressure on the VWC to keep the handpump working (World Bank Water Demand Research Team, 1993).

IWe used similar multivariate models to investigate the factors that were associated with whether or not households in a community said that they were satisfied with different aspects of their improved water system. Again, we explored a variety of definitions of our dependent variable. For Bolivia and Peru we chose the percentage of households in the village that reported they were satisfied with operation and maintenance of the water system. In Ghana we used a similar definition: the percentage of households in the village that reported they were satisfied with repairs and maintenance of the water system[14]. Table 5 reports the results of this "satisfaction" model for each of the three countries.

The striking result in the Bolivia satisfaction model is that the percentage of households in a village that is satisfied is an average of 15 percentage points higher if the village has received a PCS visit that provided financial or managerial (but not technical) assistance. This effect is large and statistically significant; it is robust to model specification and the definition of the dependent variable (Davis *et al.*, 2008). In Peru, the percentage of households living in the village that is satisfied is lower if the water system in the village is older, but this is not the case in Bolivia and Ghana.

In the Ghana model, there are a number of independent variables associated with the percentage of households in a village that report they are satisfied. First, if a village has received a technical PCS visit, the percentage of household who say they are satisfied is lower. We interpret this as evidence that the technical PCS visit was not exogenous and that villages receiving technical PCS may already have been in trouble. However, technical training was positively associated with satisfaction. Consistent with the finding from Bolivia, if a village had received a PCS visit providing managerial or financial assistance, a higher percentage of households reported being satisfied. Villages in which a higher percentage of households reported that they trusted their neighbors also had a higher percentage of households who were satisfied with the repairs and maintenance of their water system. Finally, in Ghana villages with large populations per borehole, a lower percentage of households were satisfied, which we interpret as consistent with the results for population per borehole in Table 4.

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[14] We chose to look at satisfaction with repair, maintenance and operations because these are within the control of the community. Satisfaction with water quality or overall satisfaction with the system may depend on construction and water-resource related factors over which communities have little control once construction has been completed.

Table 5. Factors associated with households' satisfaction with O&M repair services.

	Bolivia	Peru	Ghana
Dependent variable	HH satisfaction with O&M (% satisfied)	HH satisfaction with O&M (% satisfied)	HH satisfaction with repair and maintenance (% satisfied)
Remoteness	β: −0.01	β: 0.00	β: 0.00
	(SE = 0.04)	(SE = 0.00)	(SE = 0.00)
Electricity coverage	0.18*	0.00	0.00
	(0.07)	(0.01)	(0.00)
Technical PCS visit	−3.21	0.07	−0.97†
	(5.59)	(0.08)	(0.031)
Financial or managerial PCS visit	14.64*	−0.02	0.06*
	(7.32)	(0.12)	(0.03)
Technical training	1.94	0.06	0.06†
	(5.06)	(0.04)	(0.02)
System age	−2.17	−0.02*	−0.001
	(1.95)	(0.01)	(0.015)
Trust of neighbors	0.74†	0.12	0.003†
	(0.14)	(0.14)	(0.001)
Region or program dummy variable	−1.58	0.09‡	0.015
	(5.78)	(0.05)	(0.028)
One borehole			−0.012
			(0.023)
Population per borehole			−0.004*
			(0.002)
Reliable alternative source			−0.03
			(0.026)
Intercept	27.40‡	0.68†	0.63
	(16.35)	(0.12)	(0.13)
Pseudo R^2 value	*0.30*	*0.08*	*0.17*
Number of observations	*77*	*89*	*175*

* Significant at 0.05 level.
† Significant at 0.01 level.
‡ Significant at 0.10 level.

6. Discussion

We are unaware of other reports from the field of such encouraging findings from large numbers of rural communities in different countries. If these findings turn out to be as robust as we hope, it seems that the demand-driven, community management model, coupled with access to spare parts and some technical expertise, has come a long way towards unraveling the puzzle of how to best design and implement rural water supply programs in developing countries.

Our conclusions on the relationship between PCS and sustainability are more tentative and merit further investigation in other field sites. The communities in our study solicit and use a wide range of PCS services that are available to them. Nonetheless, we find no evidence that the provision of free repairs or free technical assistance, or that implementing an intensive supply-driven PCS program like MOM in Ghana, are positively associated with improved technical sustainability or increased household satisfaction. This supports the wisdom of the original conception of the demand-driven community management model—that communities can and should take full responsibility for their systems. The non-solicited PCS activities that appear most promising from this study are those that help communities renew and further develop their capacities: post-construction training for system operations and non-technical support visits to help VWCs with administrative functions or water use disputes.

Our findings also present some challenges for the sustainability of investments in the rural water sector. One overarching issue is that even the communities we studied where cost recovery systems seem to be meeting program objectives (i.e. villages pay 5–10% of capital costs and collect tariffs to cover operation, maintenance and repairs) are not moving toward a financially sustainable future in which they can (1) replace infrastructure when it reaches the end of its economic life, or (2) expand system capacity to accommodate population and economic growth. Donor-funded rural water supply programs have been structured as one-time investment programs, designed to meet only the immediate needs of rural communities. This means that the moral obligation assumed by higher level government and donors is not over. The current financing system ensures that these communities will keep returning for capital subsidies, just as some are doing now for repairs.

Some might argue that this is not a problem, that as long as poor people need help they should get it. But the indirect consequences of this capital financing model need to be carefully considered. In Ghana, part of the reason some households continue to rely on traditional sources appears to be that capital subsidies were spread too thinly and that an insufficient number of boreholes were installed to serve a growing population. In Bolivia, one consequence of a per-capita cap on capital expenditure (designed to provide a disincentive for communities to ask for capital-intensive, perhaps inappropriate, facilities) seems to have been that some communities restrict their service boundaries and leave households on the periphery without piped services. Although these unconnected households were provided with wells, they may prefer in the future to upgrade to the level of service enjoyed by their neighbors. Expanding coverage in these Bolivian systems will be complicated by the fact that the water sources in many villages do not have sufficient water to serve additional people. Two-thirds of the women who participated in focus group discussions felt that the quantity of water provided by PROSABAR systems was insufficient or “just enough to meet community needs”. Approximately 20% of the PROSABAR communities studied have experienced decreases in the quantity of water supplied during the dry season since their system was constructed.

In large municipalities, new water systems are routinely designed with excess capacity in both the distribution system and the water source to provide for growing populations. But everywhere in the rural water sector, capital subsidies are limited and excess system capacity is one of the first casualties. Moreover, few demand-driven rural water supply programs have incorporated a systematic approach for providing follow-up capital subsidies to villages that have outgrown their current systems or want to upgrade to a higher-level of service. Some of the communities in Ghana need to plan for piped distribution systems that can support new businesses and other enterprises and the current model for the provision of subsidized boreholes will not make this transition easy. Without the option of gravity-fed distribution systems such as in Peru and Bolivia, the Ghanaian communities will have higher O&M expenses. They will also need to plan for expenditures for system expansion. For a village to do this on its own will require a cost recovery system that can generate a much higher and more regular stream of revenues.

This brings us to a second major challenge for water sector professionals that is brought to light by this study: why is it that the VWCs in a significant number of villages are not collecting tariffs at all, or collect insufficient revenue from households to cover the financial costs of major repairs, much less the costs of system expansion or capital replacement? One possible explanation is that the initial capital contribution that villagers made was not an adequate "demand filter": making a nominal contribution to capital costs (5–10% of capital cost through cash or in-kind contributions) was not enough to ensure that households in the recipient communities would be willing to pay the full financial (and non-pecuniary) costs of operating and repairing their new systems. We cannot rule out a possible link between low capital contributions and poorly performing tariff collection systems, but neither do we have evidence that increasing the initial capital contribution would lead to better cost recovery from households. Rather, our findings suggest three principal reasons that VWCs are unable or unwilling to charge households more.

First, generating substantial cash balances creates tough problems for the VWCs. These rural communities do not have access to a convenient, secure banking system for the management of cash. The median distance to the nearest municipality among the Bolivia villages in our sample was 24 km and the average Peruvian village was 15 km from a paved road. Villages in Ghana are on average located 15 km from the urban centers where the area mechanics live and work. Moreover, many households have little cash to spare and cash flow is irregular and highly seasonal. Households are also often distrustful of the accounting and security of cash balances and VWC members may be distrustful of each other or not want the responsibility of securing cash.

Second, when VWCs do accumulate cash balances, villages often want to spend these monies on other development projects. There is thus little incentive for VWCs to attempt to generate the funds necessary for major repairs to the water system if they will "lose" them anyway. In such a situation, it makes sense just to wait and try to raise the funds when the need arises. For all these reasons, life is much simpler for members of VWCs if cash is only sufficient to pay for minor O&M costs or is only collected at the moment funds are needed.

Third, VWCs may well be correct to believe that future capital and repair subsidies will be forthcoming from donors, NGOs and higher levels of government when they are needed. Not only was the vast majority of the capital for these projects provided at no cost to the communities at the time of construction, but a significant number of VWCs in our sample have successfully found ways to insulate households from the cost of repairs to the water systems. They have obtained donations, free spare parts and free repairs from a wide variety of NGOs, church organizations, private individuals and companies and even local governments. Herein lies a third major challenge for rural water supply policy: does the sector's current capital financing model—and the post-construction activities of these NGOs and other actors—create a moral hazard that will undermine the principle of community self-reliance in the post-construction phase?

In Ghana, the fact that 1 in 6 of the sample villages had received grants from outside sources after the construction of the project may not seem like much, but this means that almost all VWCs would know that NGOs and others are active and nearby. It may seem like a reasonable bet to wait until major repairs are needed and see if an NGO might provide the cash infusion required. Moreover, an effort by a VWC to establish some kind of sinking fund to make major repairs and replace capital at some future date may make the community "less needy" to the NGO and actually preclude the community from receiving such support. Indeed, small towns in the United States face similar disincentives to financing their own capacity expansion and system rehabilitation.

From the perspective of the NGO, repairing a handpump or fixing a broken transmission line for a piped distribution system may well seem like an ideal project. With a relatively small amount of incremental funds, the NGO can reasonably claim to its donor base that all benefits of the infrastructure are due to its involvement, because without the incremental investment the system would have remained broken. NGOs (and other donors) are especially attracted to such opportunities where their funds have great "leverage". But this funding strategy raises two important questions. First, would the community have managed to raise funds locally and made the repair if the NGO had not been standing by ready to step in? Second, if all the credit for the infrastructure goes to the "last investor" in, who is going to be willing to continue making the capital infusions necessary to replace the aging capital stock, that is, to do the "heavy lifting" that is required under this capital financing model? Will higher levels of government and donors step into these rural communities 5 or 10 years down the road when these systems are fully depreciated and replace the capital that NGOs have kept running?

The present situation in the rural communities in our sample is not financially sustainable without new infusions of capital investments in the relatively near future—both to replace existing infrastructure and to provide for economic growth. The moral hazard from the active involvement of NGOs, religious groups and other non-state actors in the rural water sector is likely to prove to be an important factor undermining cost recovery efforts and may discourage communities from making their own investments in water infrastructure to support economic growth.

Long-term financial sustainability requires a different policy model. Communities do want and need help, but this assistance should not perpetuate their dependency on NGOs or higher levels of government for limited capital subsidies that lock communities into infrastructure systems that are not suited for achieving economic development or for accommodating growing populations. Nor should it undermine local initiatives to pay for higher levels of infrastructure or infrastructure expansion. The coordination of the policies of NGOs with government and with each other seems especially important and worthy of future research. The involvement of NGOs in the sector has proven important for fostering policy innovation, serving the very poorest and helping communities find the resources they need to keep their water systems running. But as suggested by our findings, NGOs can also create moral hazard problems that may ultimately undermine rural economic development. One important role for NGOs in the future could be as a catalyst for PCS, rather than as dispenser of capital subsidies for communities that cannot manage to repair their water projects.

In summary, the demand-driven, community management planning model has come a long way towards finding the key to success in the rural water sector. The next frontier seems to be the design of a policy framework that will enable communities to handle the twin challenges of system rehabilitation and expansion.

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