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Post-construction support and the sustainability of rural water projects in Ghana

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Many rural community-managed water supply programs in developing countries have been characterized by poor performance. In response, governments and non-governmental organizations have organized two types of “post-construction support” for village water and sanitation committees. The first, “demand-driven” approach leaves it largely up to communities themselves to seek out repair and other support services and to pay for them when needed. The second is a more “supply-driven” approach – to provide unsolicited technical assistance, training, trouble-shooting, and even financial assistance to communities. We evaluate the effect of these types of post construction support on the technical sustainability of community water supplies in rural Ghana using data collected from 200 villages in Volta and Brong Ahafo.

Introduction

Many rural water supply programs in developing countries have been characterized by poor performance. Water planners have searched for the underlying reasons why success in the rural water supply sector has proven to be so elusive. Engineers blame poor quality construction, anthropologists describe a lack of community participation, political scientists report rent-seeking and poor governance structures and economists complain of poor pricing and tariff design (Therkildsen, 1988, World Bank Water Demand Research Team, 1993). In the 1990s a consensus of sorts emerged that pre-project planning procedures for rural water supply programs needed to be more “demand-driven” – involve households, and women in particular, in the choice of technology and of institutional and governance arrangements and require households to pay a larger share of the costs of providing water services and some of the initial capital cost (Sara et al., 1996; Sara and Katz, 1997; Whittington et al. 1998). This consensus was largely silent on what type of support communities might need after construction. Recently some have argued that it is unrealistic to expect that rural communities can be left to their own devices after a water project is completed, and that for rural water supply systems to be successful, communities need some post-construction technical assistance (Lockwood, 2003). Without access to a reliable supply of spare parts and to sufficient technical expertise to repair problems, it stands to reason that all handpumps would over time fail. The unresolved question is what form post-construction support (PCS) should take and what types of PCS are most effective.

Two broad strategies for providing PCS have emerged. The first, “demand-driven” approach is to ensure that spare parts and technical services are available, but then leave it largely up to communities themselves to seek out such services and to pay for them when needed. The second is a more “supply-driven” approach – to provide unsolicited repairs, technical assistance, training, and trouble-shooting to communities. In Ghana, both “demand-driven” and “supply-driven” PCS systems exist, and both government and non-governmental actors are involved in support activities. This paper draws on data from 200 villages in Ghana’s Volta and Brong Ahafo regions to examine whether unsolicited post-construction assistance is positively associated with technical sustainability of non-mechanized handpump systems.

In contrast to other recent findings in the literature (Engel, S. et al., 2003), our results show that the majority of boreholes in the sample villages are in fact working. Boreholes in the sample villages do break down often, but most water and sanitation committees in the study villages in both Volta and Brong Ahafo effectively manage to mobilize the resources needed to make minor repairs in a matter of a few days. We find two forms of post-construction support – additional training for village caretakers and regular visits by DWST members – to be positively associated with having working handpumps.

The rural water supply sector and post-construction support in Ghana

The World Health Organization and UNICEF's Joint Monitoring Programme for Water Supply and Sanitation (2001) has estimated that about 62% of Ghana's rural population has access to improved water services. As in many developing countries, various external donors provide much of the financing for capital investments in rural water supply projects in the different regions of Ghana. Since 1995, the Ghanaian Community Water and Sanitation Agency (CWSA) has been responsible for the coordination and facilitation of activities in the sector (Edig, A. et al. 2002). CWSA's national strategy promotes a "demand-driven" planning approach that emphasizes participatory project design and implementation. The rural water supply projects are expected to include consultation with communities about relevant technology and management choices, and the participation of women is valued and encouraged. Once the projects are built, district assemblies hold the water systems in trust for the communities, and communities are encouraged to establish water and sanitation ("watsan") committees to manage the systems. Project implementation is expected to include initial training to these committees and special training on repair and maintenance to two village-based "caretakers" who are generally members of the watsan committee.

Once boreholes and handpumps are installed, communities are expected to be responsible for borehole maintenance and repairs. The watsan committees and caretakers have access to a well-developed, multi-faceted system of post-construction support. A central actor in the post-construction support system is the District Water and Sanitation Team (DWST), consisting of an engineer, a hygiene expert, and a community mobilizer seconded to the district government. DWST members are not supposed to do handpump repairs themselves, rather to help the village watsan committees obtain the support and training they need to run and repair the systems, to help resolve any management and water use conflicts that arise, and to plan new capital projects. The DWSTs visit watsan committees on request, and assist communities in finding spare parts if asked to do so. They also visit some communities on their own initiative to check on conditions and organize training sessions on topics they consider to be relevant. However, the financial resources available to the DWSTs to carry out these functions are limited and vary across districts. How much attention a village receives from a DWST is dependent on both how pro-active the village is in requesting assistance and on the resources and priorities of the district-level team.

Another important resource for watsan committees are the "area mechanics" living in the district. These are private individuals originally trained during the project implementation process to do routine maintenance or repair work on boreholes at the request of communities. Area mechanics are frequently called upon to obtain the spare parts needed by the community and then to install these parts. Communities must pay for the services of the area mechanics from revenues collected from village households or money obtained in some other way. The DWSTs may help watsan committees link up with an area mechanic when major repairs are needed.

Area mechanics, caretakers, and watsan committee members obtain spare parts from a system that includes a central spare parts warehouse in Tema, Ghana, and three subnational warehouse outlets in the northern, middle, and southern zones of the country. The warehouses and outlets are needed to ensure the availability of pump parts for the four standard handpumps used in Ghana (Nira, Afridev, Ghana-modified Indian Mark II, and French Vergnet). Efforts are underway to have at least one spare parts outlet in each region.

The services provided by the area mechanics and the spare parts outlets are largely demand-driven forms of PCS in the sense that communities receive them if they request or seek assistance. Communities pay for the services of the area mechanics and for the spare parts. The work of the DWSTs is also largely demand-driven assistance (responses to community requests), though some villages also receive unrequested support.

Ghana has one official PCS program (in the DANIDA operating regions) that is not linked to demand for PCS services: MOM (Monitoring of Operations and Maintenance). This is a program of quarterly visits to communities by the district Environmental Health Assistants (EHAs). During their visits, the EHAs do a technical assessment to determine how well the boreholes are functioning, review financial records, and check on payment practices. The records of these quarterly audits are compiled at the district level, in theory giving district-level officers a systematic picture of what is happening in the district. In 2002 and 2003, the Danish aid agency DANIDA funded MOM in the Volta region. Since 2004, the responsibility for the program has fallen to the district governments in Volta. Only four districts continued the MOM audits on a quarterly basis after the program reverted from DANIDA back to the district governments. Other districts have reduced the frequency of these EHA visits due to resource constraints.

Next to these government-provided PCS systems exists a series of less-systematic forms of post-construction support provided by a myriad of different actors. Some villages receive grants to fund repairs or new boreholes through Members of Parliament, ethnic organizations, or private companies active in the villages.

Others have enjoyed free handpump repairs provided by the Church of Latter Day Saints or NGOs. Contrary to PCS protocol in Ghana, DWST officials and area mechanics have also repaired handpumps for free on occasion.

In short, villages in Brong Ahafo and Volta have access to the official “demand driven” PCS infrastructure of area mechanics, DWSTs, and spare parts networks. To make a repair through this system, they must find a way to contact a service provider and to pay for the parts or services they need. The MOM system provides Volta villages one extra avenue for obtaining advice and contacting service providers, but does not relieve villages of the responsibility to pay for parts and services. Some villages in each region do manage to avoid these requirements by obtaining free repair services or a grant to cover their repair costs. Much of the “free” assistance comes from private, religious, or non-governmental organizations.

Analytical framework, methods, and data collection

In this paper, we examine the relationship between unsolicited PCS and the technical sustainability of rural handpump systems that are between 4 and 8 years old. Our village-level indicator of technical sustainability of the borehole and handpump is a dichotomous variable that measures whether all project handpumps were working at the time of the research team’s visit to the village. We employ logistic regression analysis to test for an association between various forms of PCS and this indicator of technical sustainability.

We hypothesize that sustainability (S) at the village level is a function of project, village and household-level variables:

$$S_i = f(\text{Project}_i, \text{PCS}_i, \text{System}_i, \text{Watsan}_i, \text{Village}_i, \text{HH}_i) \text{ where}$$

- S_i = Technical sustainability of the water system in the i th village;
- Project_i = Village level pre-construction factors (e.g. community involvement in project planning)
- Post_i = Post-construction support (e.g. technical assistance, free borehole repairs, grants, training during the post-construction period);
- System_i = Village-level water system characteristics (e.g. years since pump installation, number of project boreholes, availability of an alternative water source during the dry season)
- Watsan_i = Characteristics of the village level management structure (percent of committee members who are women, presence of village-level caretakers)
- Village_i = Village characteristics (population per handpump, ethnic homogeneity of the population, distance from area mechanic)
- HH_i = aggregate measures of village household or resident characteristics (median household expenditure level, percent of households who say they trust their leaders, percent of households with electricity)

To collect the information required to estimate this model, we first selected a sample of 200 villages in Ghana. The villages selected represent the range of PCS services currently available in Ghana. We selected sample villages from all four Volta districts that had continued to receive regular quarterly MOM audits after responsibility for this program was returned to the districts (Ho, Jasikan, Kadjebi, and Nkwanta). Brong Ahafo was chosen as the second region for this study because it has conditions similar to those in Volta in terms of water resources and rural water supply program design¹. Moreover, as in Volta, villages in Brong Ahafo did not have access to a spare parts warehouse within the region and showed variation in the distance from the urbanized regional capital. We selected villages from the five Brong Ahafo districts in which district-level socio-economic data best matched the Volta districts in our study (Asunafo, Dormaa, Kintampo, Tano, and Wenchi).

Within the districts selected in Volta and Brong Ahafo, we restricted our sample frame to villages that had received no more than two deep boreholes with non-mechanized handpumps, at least four years before the fieldwork. These sample selection criteria yielded a potential sample frame of 97 villages in the Volta region and 120 villages in the Brong Ahafo region. All 97 villages for the Volta region were selected, and 103 out of the 120 villages in the Brong Ahafo region were random selected.

Various data collection exercises were conducted in each village, including 25 interviews with households chosen at random in each village (leading to a total sample of 5000 households)², interviews with the village water supply committee in each village, focus group discussions, technical assessments of the handpumps, and observations of water collection at the handpumps. Fieldwork ran from late March to early May 2005. The research team typically spent one entire day in a village collecting data.

Results

Profile of sample villages

The sample villages in Brong Ahafo are quite similar to those in Volta in many respects, such as access to means of communication and access to natural water sources. There are, however, some differences between the regions. Villages in Volta are on average closer to paved roads (5 km versus 17.2 in Brong Ahafo) and more likely to have electricity (46% versus 18%). Villages in Brong Ahafo contain on a higher percentage of landowning households (62% versus 49%) and have more access to cash within the village, as measured by the median monthly cash expenditure of households in the village (US\$66 per month per household in Brong Ahafo versus US\$49 in Volta). As anticipated, the structure of village-level water management and project implementation in Brong Ahafo appears to be quite similar to that in Volta. The largest differences occur in reported community involvement in pre-project decisions about the technology to use and where to site the borehole (more involvement in Brong Ahafo than Volta) and in involvement of women in tariff design (more involvement in Volta than in Brong Ahafo).

Profile of technical sustainability and the functioning of water systems in the two regions

Almost all of the study villages in both Volta (96%) and Brong Ahafo (96%) have experienced borehole breakdowns since their system was constructed. This in itself is not an indication of project failure or neglect; it is simply a feature of the technology. Most handpumps in the sample were in fact “working” at the time of the survey. Only 12% of villages in Brong Ahafo and 8% in Volta were without a functional handpump or borehole at the time of the fieldwork³. Households reported that it took an average of 18 days to repair the last breakdown in Brong Ahafo and 22 days in Volta. Roughly half of watsans in both regions indicate that it is “easy” or “very easy” to get technical assistance for a problem that they cannot fix themselves.

When water systems are working, they seem to have succeeded in both regions at providing water to most households in the villages. Virtually all households rely on the project handpumps for at least part of their water use: 96 % of households in the average Volta village and 98% the average Brong Ahafo village reported collecting at least some of their water from the project borehole. The presence of the handpumps has not eliminated all use of unprotected water sources for drinking and cooking purposes. About half of the sample households in both regions report using a river, stream, or other surface water source during the rainy season, and a quarter report using that water for drinking.

The rural water supply model in Ghana expects watsan committees to collect money from households to fund repairs. However, it is clear from survey responses that many watsans do not have a regular revenue collection system in place and that many households are not paying even when such a system does exist. Fourteen percent of the watsans in Volta, and 41% in Brong Ahafo, either do not collect revenue from households or only do collections when it is necessary to pay for a repair. Fifty-four percent of the watsans in Volta and 24% in Brong Ahafo say they have a pay-as-you-fetch system in place, generally with a charge of US\$0.01 (or one-half a cent) for 18-20 liters. The rest of the watsans say they charge households for water through a fixed fee system (e.g. per household per month).

Information from households confirms that watsans in Volta are more likely to be collecting money from households. In only 3 percent of Volta villages, versus 42 percent of Brong Ahafo villages, all households interviewed said that they did not pay anything for water (suggesting that villages either are not investing resources in their water systems or have access to grants or free repairs). In nearly 70% of villages in Volta, and only 40% of villages in Brong Ahafo, at least 90% of household interviewed reported paying for water. The average reported monthly expenditure for water among households that pay for water was also similar in the two regions (Volta: US\$0.99, and Brong Ahafo: US\$0.89).

Profile of post-construction support

Roughly 70 percent of villages in both regions report receiving visits from the DWST, and there is no significant difference in the frequency of visits in the two regions. The number of villages that have received training in the post-construction period from the DWSTs is also similar, and the watsans provide a similar assessment of the responsiveness of DWSTs to their requests. Thus, the existence of the MOM program in Volta does not appear to have generated significantly different DWST activities in the two regions.

The watsan’s assessment of the spare parts network does differ between Brong Ahafo and Volta. Watsans in Brong Ahafo are significantly more likely to say that they have sufficient access to spare parts. On the other hand, more villages in Volta reported improvement in their access to parts since 2001.

On average, the villages in Volta have received more training and more assistance with financial and ad-

ministrative matters than those in Brong Ahafo, as one would expect given that only Volta villages are in the MOM program. When asked what they found most useful about the MOM audits, watsans in Volta pointed to help with general management; financial records and tariffs; and to hygiene education and borehole cleanliness; very few watsans in Volta mentioned help with repairs or technical aspects of borehole management.

Thirty percent of the villages in the sample (35% in Volta and 25% in Brong Ahafo) had received some form of financial assistance (a grant or a free repair) to supplement revenues they have collected internally. Thirty-three percent of villages in Volta and 13 percent in Brong Ahafo have received free repair or maintenance services on at least one occasion since 2001. In the majority of cases, this assistance was not directly requested by the village. NGOs or religious organizations provided the free help in half of these Volta cases. The Church of Latter Day Saints has been very active in this region, and much of their support involved major rehabilitation of handpumps. The rest of the Volta cases and most of those in Brong Ahafo involve free repair or maintenance assistance from the DWST or, in a few cases, from the area mechanics.

Post-construction support and technical performance

Table 1 reports the results of the logistic regression model that we used to examine the association between PCS and our indicator of technical performance (=1 if all of the 1 or 2 project boreholes in the village are working; 0 otherwise), as well as the summary statistics for variables used in the regression model. The signs of the non-PCS variables in the model are as expected, and many of the control variables are statistically significant.

If a village had only one borehole, it was more likely to be working. We interpret this to mean that the watsan makes more effort (and is under more community pressure) to keep a handpump system working when failure would leave the community without any improved water supply. The population per handpump is negatively associated with technical sustainability. This could mean either that more intensive the use of the handpumps leads to the need for more difficult or expensive repairs or that households value the handpumps less when they are shared with more households (and thus put less pressure on the watsans to fix them). Villages that have a reliable unimproved water source within one kilometer of the village were *less* likely to have functioning handpumps. We understand this to mean that households put less pressure on watsans to fix broken pumps when they have an alternative source nearby (World Bank Water Demand Research Team, 1993).

The model also shows that villages where a larger percentage of the watsan members are women are more likely to have functioning systems⁴. Likewise, trust in the village leadership, ethnic homogeneity, and electricity coverage (a measure of wealth) are all positively associated with technical sustainability. Interestingly, system age, distance from the nearest area mechanic, and having a caretaker in the village *are not* significant in the model. This is noteworthy because it is consistent with the idea that the post construction support system is working to neutralize what one would otherwise expect to be a negative effect of system age, remoteness, and problems with the village-level management structure on sustainability⁵.

Turning to the PCS variables in the model, post-construction technical training for village caretakers is positively associated with system performance. Thus, it is not so much having a caretaker, but rather having a recently trained caretaker, that would seem to help keep systems running in these villages. Receiving regular visits from DWST members (at least once a year) is also positively associated with having functioning systems.

On the other hand, receiving free repairs, grants, or help with financial and managerial affairs are all insignificant in this model. We have elsewhere (Whittington et al, forthcoming) observed that financial and managerial PCS is positively associated with increased household satisfaction with the system management and maintenance, though not with technical performance.

Table 1. Summary statistics and regression results			
Variable name	Variable definition	Mean (st. dev)	B (s.e.)
System working	All project-installed handpumps were working and providing water at the time of the fieldwork		
One handpump	1=village received only one hand pump	0.50 (0.50)	2.08*** (0.73)
System age	Years since installation of handpumps	6.01 (0.76)	0.22 (0.55)
Reliable unprotected source	Village has unprotected source that always has water during the dry season within 1 km of the village	0.19 (0.38)	-2.07*** (0.80)
Population per handpump	Population per handpump installed by project (100s of persons)	6.78 (6.83)	-0.11** (0.05)
Average expenditure	Median monthly household expenditure in village	57.6 (19.8)	0.01 (0.02)
Electricity	Percent of hhs interviewed with electricity	14.2 (24.2)	0.10** (0.04)
Remoteness	Distance in kilometers to area mechanic	19.5 (18.1)	0.01 (0.02)
Trust of leaders	Percent of hhs interviewed who say they trust their village leaders	77.4 (15.8)	0.04* (0.02)
Ethnic homogeneity	Percent of population represented by the largest ethnic group	74.1 (22.5)	0.03** (0.02)
Caretaker	1= village still has a caretaker	0.83 (0.38)	0.09 (0.86)
Women on watsan	Percent of watsan members who are women	0.49 (0.50)	0.03* (0.02)
Post-construction technical training	1= During the post-construction period, water system operator or village caretaker has received technical training	0.38 (0.49)	1.71** (0.82)
Free repair	1= village received ≥ 1 unsolicited free repair	0.15 (0.36)	-0.43 (0.80)
Financial or managerial PCS	1= received ≥ 1 visit to assist with financial or management matters ⁶	0.31 (0.46)	-0.15 (0.95)
Regular DWST visits	1= village receives visits from DWST members on a regular basis (at least once a year)	0.23 (0.42)	2.18** (1.05)
Cedis	1= Cedis received as grants for new boreholes or repair of existing systems (100s of cedis)	3.41 (19)	0.05 (0.05)
Volta/MOM	1=village is located in Volta Region	0.49 (0.50)	0.11 (1.03)
Intercept			-7.70 (4.55)–
*Significant at .10 level– **Significant at .05 level– ***Significant at .01 level– – – Pseudo R2 = 0.3835			

The MOM/Volta variable is also insignificant in the model. This could be explained by the fact that the dummy variable picks up differences between Volta and Brong Ahafo for which we have not been able to control in the model. Nonetheless, the finding at least raises the question as to whether a supply-driven PCS program such as MOM is really necessary for ensuring technical sustainability in a context like Ghana where communities have access to many other forms of PCS.

Discussion

These initial conclusions about the relationship between post-construction support and technical sustainability merit further analysis⁷ and investigation in other field sites⁸ with a more rigorous research design. Nonetheless, it is clear even from this cross-sectional analysis that most rural water supply systems in our sample are working, and that watsans and caretakers are taking advantage of the many types of PCS that are available in Ghana to find parts, fix their systems, and (in some cases) even fund repairs.

From this analysis, the types of unsolicited PCS that appear most promising for achieving technical sustainability are technically-oriented forms of support -- training for caretakers (to help maintain the local capacity to make repairs) and regular (though not necessarily very frequent) visits from DWST members. We have not, however, attempted to determine whether the benefits of these PCS services exceed the costs of providing them. That would be an important question for future research, as forms of post-construction support that have a positive impact on sustainability will not necessarily be cost effective.

Importantly, we find no evidence that relieving watsans of their responsibilities through the provision of free repairs is positively associated with technical sustainability. Nor do grants seem to help. While free repairs and grants may offer welcome short-term fixes for villages, they are not necessarily associated with improved sustainability over the medium-term. In light of this finding, NGOs and other organizations involved in the provision of free repairs and grants in Ghana should think carefully about their choice of intervention strategy and consider how their work fits into the PCS framework in the country.

This study also raises important questions about the added value of the MOM quarterly audit program. The MOM program seeks to help watsans with three types of issues – hygiene and cleanliness, financial and managerial issues, and technical sustainability. We did not investigate whether the MOM program improved hygiene, water use habits, or cleanliness of the handpump sites, all of which would be expected benefits of regular visits by environmental health assistants. As for financial and managerial issues, not all watsans in the MOM program perceived that they had received assistance with financial or managerial issues; thus, there may be some important differences in the way the program is carried out in different districts by different EHAs.

Our study was designed to help evaluate the contribution of MOM to technical sustainability. We faced difficulties isolating the effect of MOM in our model since all villages in the Volta region received this form of assistance; thus, we are cautious about our finding that MOM is not positively associated with improved technical sustainability. Nonetheless, our work revealed other, less intensive (and thus perhaps also less expensive) forms of technical PCS (i.e. regular DWST visits and caretaker retraining) that *are* positively associated with technical sustainability. At a minimum, this suggests that an intensive routine of regular visits to communities may not be of significant added value in places like Brong Ahafo and Volta, where watsans have access to many forms of demand-driven PCS. In future research, it would be interesting to evaluate whether the effect of a MOM-like program would be more significant in other settings where fewer PCS resources are available.

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Keywords

post-construction support, rural water supply, sustainability, Ghana

Note/s

- ¹ Villages in Brong Ahafo received systems through the World Bank-funded Community Water Supply Program I, which used a-project approach very similar to that of the Danida-funded program through which the Volta systems were installed.
 - ² The selected villages ranged in size from approximately 150 residents to 5000 residents. The total population of the villages selected for the Brong Ahafo sample is about 75000, and for the selected Volta villages just over 100.000.
 - ³ We considered handpumps not to be working if they were completely broken down or unusable, if the handpump was broken, if the handpump produced no water after 30 strokes, or if the borehole did not have water year-around.
 - ⁴ The significance, but not the sign, of this variable varies with the exact model specification.
 - ⁵ In the case of system age, the lack of variation in this variable (4 – 8 years) may also explain its insignificance in the model.
 - ⁶ Theoretically all villages in Volta should have received assistance with financial and managerial matters through the MOM program, but not all watsans perceived the MOM audits as such.
 - ⁷ In a forthcoming paper, we will also use village-level matching techniques to examine the relationship between PCS and sustainability in the Ghana case.
 - ⁸ This World Bank funded project also included studies of PCS in Peru and Bolivia (Davis et al 2007, Prokopy et al 2007).
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