Evaluation of user satisfaction of rural water supply in Yemen

Ahmed M. Alderwish and Jane Dottridge

ABSTRACT

This paper compares rural water supply (RWS) and sanitation project schemes where national policies on RWS had been adopted against schemes constructed by public authorities as part of the General Authority for RWS Project. This evaluation tests the policies and provides a comparison of donor supported and government projects. The results indicate that policies will result in relatively high levels of beneficiary satisfaction and will increase the likelihood that the communities will sustain the systems over their design lives. More confidence in Water User Associations as governing and management bodies for water schemes is medium and more transparent selection processes are required. Although beneficiaries are agreeing to and paying tariffs that cover operation and maintenance costs, it affects the quantity of water they use and leads to negative health impact. High percentages of respondents have expressed dissatisfaction with current water charges, water quantity and water quality. Findings suggest that RWS Project's strategy for developing communities' capacity and meaningful involvement in planning and managing their own water systems is effective, however, progress is needed in two areas: RWS subsector still lacks a clearly agreed strategy and a demand-responsive approach should be adopted strictly in all programs.

Key words | rural, survey, user satisfaction, water supply, Yemen

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INTRODUCTION

Meeting the Millennium Development Goals (MDGs) in water supply and sanitation (WSS) in Yemen is a formidable challenge for several reasons. First, the country is challenged by an inhospitable and dry geography. Second, the predominantly (75%) rural population is typified by small tribal communities dispersed in approximately 100,000 scattered settlements. Third, many of these villages are situated on rocky mountain tops, making service delivery and outreach difficult and expensive. Finally, only 41% of the population have access to health services, and less than 31% have adequate access to water and sanitation services, as illustrated by Figure 1.

In recent years, the Government of Yemen, with support from the World Bank, has initiated several projects and programs to improve WSS in rural communities. These programs have contrasting institutional and technical designs, for example they range from being strongly community-driven to strongly government-led programs, in which communities are provided with infrastructure through centrally managed programs.

The World Bank funded Rural Water Supply and Sanitation Project (RWSSP) was perhaps the most community driven of the initiatives; it provides users with a relatively open menu of choices of service levels, within the technical and resource limitations of the community, and management arrangements. The RWSSP was designed to develop and test approaches for sector programs that implement national policies. The RWSSP focused more strongly than other rural water supply (RWS) programs in Yemen on developing the capacity of communities to take on the delegated responsibilities of planning and managing their own water systems. In contrast, the national General Authority of Rural Water Supply Project (GARWSP) adheres, to varying degrees to the guiding principles of a

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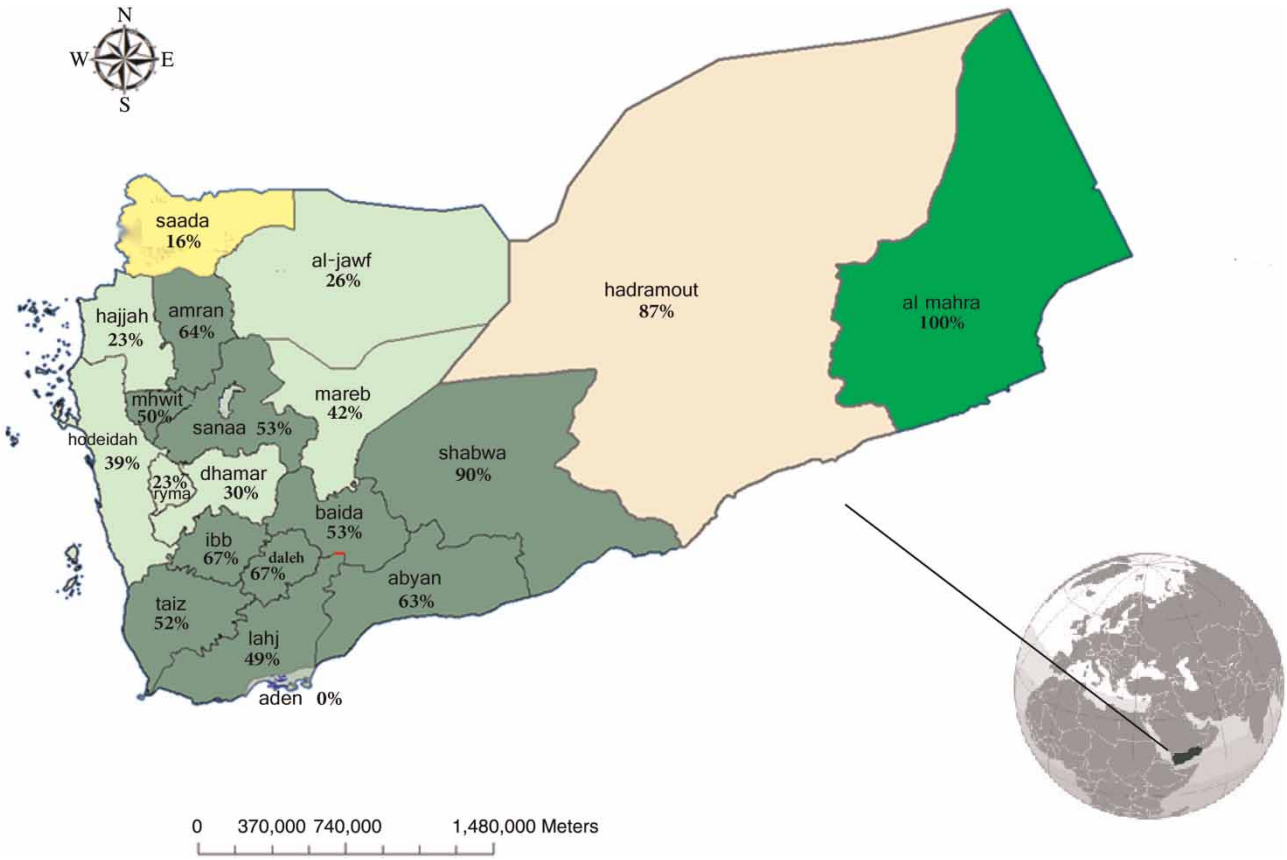

Figure 1 | Coverage (%) of rural population by Public/Private water supply Networks in Yemen (2010).

'decentralized, demand-responsive approach to rural WSS development, improving cost effectiveness by identifying means to implement projects that meet basic needs at lower costs'.

The success of RWS programs requires access to improved services to be both efficient and sustainable. Efficiency considers both technical aspects and allocation, but essentially reflects least cost provision, where costs are supposed to include external factors such as environmental costs. As a result of poor efficiency in RWS in past decades, many reform policies have focused on reducing costs and improving revenues.

Consumer satisfaction with RWS services provides a useful measure of the success or failure of a RWS investment program and the likelihood that the infrastructure will be sustained through its design life. An analysis of user satisfaction therefore enables comparison of the different approaches. The comparison can indicate the relative sustainability of the RWS services that were constructed through the different programs. The outcomes of this survey were used to guide the design of future RWS projects.

METHODOLOGY

During 2008, a household survey was conducted in Ibb and Abyan Governorates of Yemen to evaluate water users' satisfaction with water supply services. The objectives of the survey were to: (1) assess the performance of the RWS schemes with respect to several indicators of user satisfaction with the services provided and their ability to operate and maintain water systems, and (2) compare the performance of RWSSP and GARWSP. This allows assessment of applied policies.

Sample selection for the survey was carried out in three stages. First, a record of all existing water supplies was

collated from different sources and stakeholders. Next, with support from local governments and social workers, a field review was carried out at the district and Uzla (subdistrict) levels to establish which supplies were operational. Third, operational water suppliers were arranged by source of funding (RWSSP or GARWSP).

A sample of water schemes by each donor and governorate was then selected for the detailed survey (Table 1). The advantage of staged sampling design in rural areas is cost-effectiveness because costs for enumerators to travel between villages are high. However, clustering can be a drawback when clustered populations are overly homogeneous, leading to higher standard errors and thus decreasing statistical efficiency (Lehtonen & Pahkinen 2004). Increasing the sample size is an option to achieve statistical precision. However, instead of increasing the number of households sampled per cluster, it may be advisable to increase the number of clusters sampled since it is precisely the homogeneity within groups that leads to less statistical efficiency (Bloom 1995; Duflo *et al*. 2008). This approach was used in this survey, by dividing the sample into a fixed number of clusters of 30 households each. All of the clusters were then sampled, thus allowing for full coverage of the heterogeneity of the area.

A method that allows sufficient statistical rigour for the results of the impact evaluation to come close to randomized interventions is difference-in-difference estimators. Difference-in-difference is probably the most widely applied method for evaluating donor interventions, but also the most data intensive (Todd 2008). The method relies on comparing the outcomes of interest for the treatment group with a control group, both before and after the intervention. Therefore, the applicability of the method crucially depends on whether pre-intervention data is available or can be obtained, and on whether a control group can be identified. It is essential that the control group is similar to the treatment group, but has not received any improved water system and is thus likely to reflect the situation in the treatment group if the program had not taken place.

In this study the randomization supplemented with the collection of baseline data. This allows both analysis of initial program conditions and application of difference-in-difference estimators, which were subsequently used to compare the assessment of program outputs. The change in the outcome indicator level (percent of satisfied users) for the control group equals the development in outcome caused by unspecified reasons, which affect both the control and treatment groups in the same way. On the other hand, the change for the treatment group also incorporates the program's effects, which can be either positive or negative. Through applying the double-difference method, the actual impacts of the program can thus be identified.

To assess the actual impact of the RWSSPs (treatment group), a control group was selected from the schemes constructed by the public authority (GARWSP), which applied different policies. This further allows for the comparison of donor supported and government projects and, therefore, provides useful information for stakeholders, donors and GARWSP, to determine the areas of priority and appropriate actions to be taken in order to improve satisfaction and sustainability of the schemes. In a simple way, difference-in-difference in tabular presentation is shown in Table 2.

In 2003, the World Bank Water and Sanitation Sector Board (the Board) agreed that all new dedicated projects involving water will track a standard indicator: the project's contribution to increasing access to improved water supply services. By evaluating access (a program outcome) rather than on health or poverty (a program impact), the RWS subsector can measure the success of its projects by focusing within the sector. While it is widely recognized that

Table 1 | Sample composition: number of surveyed households

Governorates	RWSSP	GARWSP
Ibb governorate	509	509
Abyan governorate	210	210

Table 2 | Tabular presentation of difference in difference method

	Before change	After change	Difference
RWSSP schemes (Treatment group)	Yt1	Yt2	$\Delta Yt = Yt2 - Yt1$
GARWSP Schemes (Control group)	Yc1	Yc2	$\Delta Yc = Yc2 - Yc1$
Difference			$\Delta\Delta Y = \Delta Yt - \Delta Yc$

health, education, and other welfare impacts are critical, it is impractical to require every RWS manager to design and implement projects to deliver these. Thus, there is a compelling rationale to focus on the outputs and outcomes of policies, programs and projects within the remit of RWS managers, such as project management, tariff reform, and regulation. Access, which is an intermediate outcome, measures the availability of RWS services to project beneficiaries (Poulos *et al.* 2006).

The applied method allows the assessment of: (1) Impact of improved RWS, through comparison between before and after the project of water quantity (consumption), access (including frequency of supply, duration of supply, water charges, water pressure and over-crowding) and water quality (including observed water quality and members of household suffering from diarrhoea); (2) Effect of applied policies on users satisfaction and thus sustainability; and (3) Users satisfaction of donor supported schemes (RWSSP) compared with government schemes (GARWSP).

SURVEY FINDINGS AND DISCUSSION

The survey compared perceptions of the users for GARWSP with RWSSP, in two Governorates: 'mountainous' Ibb with 67% water supply coverage, and 'plain' Abyan with 63% coverage. Tables 3 and 4 show summary results of the applied method for the expected outcomes from the policy-impact framework of the two programs in these governorates. Average net impact for the two governorates is depicted in Figure 2.

House water connections

RWSSP net positive impact was 40.5% in Abyan governorate, in contrast to GARWSP which intervened in areas where 55% of the population already had house water connection.

Water quantity

Although currently most of the houses are connected to networks, users of RWSSP schemes consume lower quantities of water than those of GARWSP. The reason is that RWSSP users pay based on their water consumption while GARWSP users pay flat fees or no fees. Average domestic water consumption for rural population in Yemen is 30 l/c/d which is considered to be low and would not affect water resources conservation plans. Increase in the

Table 3 | WRSSP and GARWSP: During and after intervention (Ibb Governorate), as percentage of satisfied households

	WRSSP		GARWSP		Differences		
Variable	Yt1 Before	Yt2 After	Yc1 Before	Yc2 After	Yt2 – Yt1 WRSSP	Yc2 – Yc1 GARWSP	Difference in differences DDY = DYt – DYc
House water connection	7	100	10	94	93	84	9
Water quantity	12	26	9	31	14	22	−8.3
Average water quality	83	90	92	92	7	0	7
Members of household suffered from diarrhoea	27	22	22	17	−5	−5	0.8
Frequency of supply	20	76	21	54	56	33	23.4
Duration of supply	18	76	21	59	58	37	21.2
Water charges	62	60	64	47	−2	−17	14.3
Water pressure	18	74	23	55	56	32	23.6
Over-crowded	13	44	15	34	31	18	12.4
Range	**76**	**78**	**83**	**77**	**98**	**101**	**31.7**
Standard deviation	**25.9**	**27.3**	**28.1**	**26.0**	**33.5**	**29.7**	**10.7**
Average	**29**	**63**	**31**	**54**	**34**	**23**	**11**

Table 4 | WRSSP and GARWSP: During and after intervention (Abyan Governorate)

	WRSSP		GARWSP		Differences		
Variable (% of satisfaction HH)	Yt1 Before	Yt2 After	Yc1 Before	Yc2 After	Yt2 – Yt1 WRSSP	Yc2 – Yc1 GARWSP	Difference in differences DDY = DYt – DYc
House water connection	14	100	55	100	86	45	40.5
Water quantity	54	73	53	55	20	2	17.6
Average water quality	95	95	84	85	0	1	−1.6
Members of household suffered from diarrhoea	72	74	60	70	2	10	−7.6
Frequency of supply	17	64	39	74	47	35	11.9
Duration of supply	17	63	36	65	46	29	17.1
Water charges	63	80	60	60	18	0	17.1
Water pressure	20	59	34	56	39	22	17.1
Over-crowded	14	47	25	43	33	18	14.8
Range	**81**	**53**	**59**	**57**	**86**	**45**	**48.1**
Standard deviation	**30.8**	**17.0**	**18.0**	**17.2**	**26.6**	**16.2**	**13.5**
Average	**41**	**73**	**50**	**68**	**32**	**18**	**14**

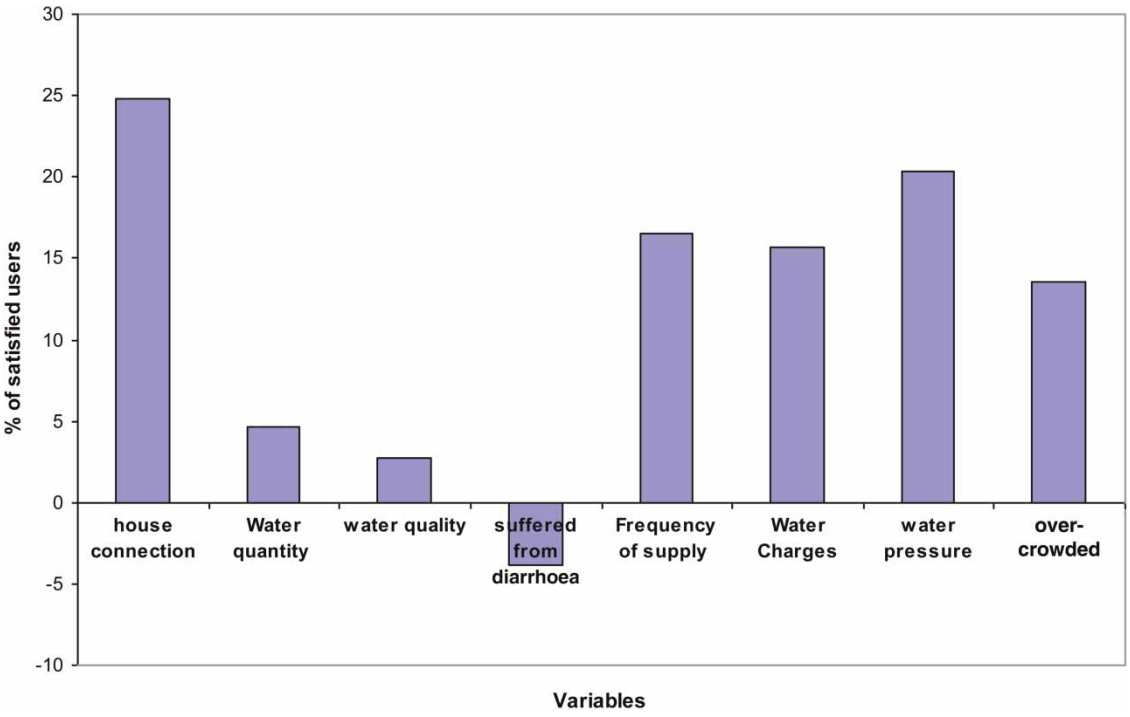

Figure 2 | Net impact due to intervention for the two governorates.

price of water supplied has restricted the amount of water used domestically by changing the way people handle it within the house. For example, instead of using running water from tap, people store and use water from containers which carries a risk of contamination. This means that even though the improved water supply services are used, the quality of drinking water does not improve and health outcomes remain unchanged because poor hygiene practices

in the household offset the positive effects of improved drinking water.

Water quality and health implication

As can be seen in Figure 2, there is only a slight or no improvement in average water quality due to improved water supply projects. Surprisingly, the numbers of household members who suffered from diarrhoea currently are higher than in the past. The World Bank in 2008 noted that 'there is overwhelming evidence that hand washing, sanitation, and household and point-of-use water treatment improve health outcomes'. In particular, there is strong evidence that household piped water infrastructure reduces child mortality, mainly through reducing diarrhoea (Curtis & Cairncross 2003; Fewtrell *et al*. 2005; Zwane & Kremer 2007). Community-level rural water infrastructure, however, seems to be less effective in reducing diarrhoeal diseases even though they lead to time savings (Zwane & Kremer 2007; Kremer *et al*. 2008; World Bank 2008). The main argument made is that water quality in the household is often not affected by improved community level water provision due to inappropriate water storage at the household level, leading to contamination of otherwise clean water. Furthermore, some studies suggest heterogeneous effects of improved water supply and complementarities between health and education. For instance, Jalan & Ravallion (2003) found that piped water has no significant impact on diarrhoea among the poorest groups which they explain by a lack of education.

The present study indicates that contamination occurs due to the need for households to store water in the house instead of using tap water directly. This need arises from the shortage of supply, inadequate quantity supplied or expense. The latter seems likely for GARWSP schemes in Ibb with a reduction of 17% in satisfied percent of users toward water charges. Although payment for consumption is generally good practice that would be expected to lead to high community participation in these schemes, proper tariffs based on affordability are essential.

Another factor contributing to perceptions of low water quality is the dominant brown colour of the water, which results from high iron content of water. The origin of iron is believed to be related to the poor material used in the pipes, network and storage tanks rather than a natural origin. This interpretation is supported by the reduced satisfaction in water quality than before the schemes. Tastes and odours are quite common in water supplies everywhere because they are caused by a wide variety of substances, many of which readily enter water systems. Naturally occurring tastes and odours are often attributable to algae and cyanobacteria (blue-green algae). An additional factor is that many groundwater sources in the mountainous areas contain minerals and chemicals at concentrations above national and international standards for safe drinking water (Alderwish 2008).

Despite these expected results, it is surprising that water quality in scheme villages is generally not better when compared with control water sources. This highlights the potential of providing more training about water handling at household level, potential sources of pollution and workshops for keeping pipes and water tanks free from pollution.

Frequency and duration of supply

The results of the RWS schemes have shown relatively low positive effects that vary between 17 and 23% with respect to the frequency of supply, duration of supply and water pressure. The implementation of RWS programs reduced the frequency of breakdowns in water delivery resulting from poor operation and maintenance, seasonal variation, and contribute significantly to the sustainability of schemes. However, 40% of households are not satisfied with the quantity of supplied water because it does not cover all their household needs. This necessitates water user association (WUA)/Supplier to revise regulation of water consumption, treat poor quality water, and find ways to overcome seasonal variations.

The policy of improving cost effectiveness by identifying means to implement projects that meet basic needs at lower costs may not be a good policy for the supply of drinking water for a rural population. This is because not all technologies are amenable to piped house connections. Some of the rural supply schemes, such as the Social Fund Development program, concentrate on low-cost rainwater harvesting and other non-mechanized technologies. Consequently many of these schemes are not used for drinking water anymore due to deterioration of water quality (ALDERWISH WES 2008).

Approaches

Regarding the institutional set up at community level, some respondents complain about WUA regarding regulation of water consumption. The selection of WUA members should be more transparent (Alderwish 2008). In general, consumers of these water supply systems did not receive information on the quality of their drinking water. Under consumer right-to-know (Office of Water, EPA 2003), consumers should be provided with this information on an annual basis. Consumers generally indicate that they want to receive information on all aspects of their water supply projects. Increased trust in water quality and adequate information may lead to an increase in public involvement in decision making, community support for infrastructure improvements, an increase in public interaction, and consumers making more informed choices. In order to achieve these outcomes, it is critical that water programs and relevant entities utilize all outreach mechanisms available to continue to promote dialogue, raise awareness, and promote confidence.

For all RWS interventions, the schemes save time for household members particularly in mountainous areas where they often used to spend an average of 2.5 hours per day hiking into the valleys to bring drinking water (ALDERWISH WES 2008). These are traditionally household chores carried out by boys, girls and women. Consequently, school attendance of boys and girls and subsequent graduation is higher in scheme villages, and significantly more girls are in school when a scheme is present.

The low net impact of projects on water quantity, water quality and water charges indicates as expected the need to adopt a demand-responsive approach to identify communities for inclusion in sector programs and to make this approach standard practice. The demand-responsive approach is defined as the quantity and quality of water which community members will choose to consume at a given price. Price, as used here, signifies all valued resources including an individuals time or labour given in exchange for service (Sara & Katz 1998).

Even in low-income countries where there is substantial external and government subsidy to RWS, there is evidence that communities with high demand for an improved water supply find ways to solve their own problems. Many communities, such as those under the Self Help Water program in Kenya, have arranged to borrow funds and hire a contractor to design and build a more complex water distribution system (Gichuri 1995). In Bangladesh, a recent study found that over half of the rural population is supplied through private provision (Garn 1997). In addition, due to fiscal constraints in most developing countries and the institutional and financial constraints of large RWS projects, not all communities can be immediately provided with RWS services even at marginal costs (Khan *et al.* 1997). Thus, the important policy question becomes which communities should receive services first? It makes sense to give priority to investments in communities that have expressed demand for the services in advance. It can be assumed that these communities are ready and willing to maintain the service. This willingness is critical since nearly all projects expect the communities to manage and maintain their systems once they have been constructed.

CONCLUSION

In conclusion, the results for all schemes show that there is an overall positive effect regarding the sustainable provision of water to the household level, time savings for family members and school attendance of boys and girls. Despite these benefits, the overall effect still has immense potential for improvement.

The current state of findings indicates that the national policies applied in RWSSP schemes can have positive effects on user satisfaction about frequency of supply, duration of supply and water pressure of these schemes. However, the results emphasize, based on understanding of water handling at household level, that positive health effects from improved water supply in rural areas can be attained by sufficient provision of water through the taps and by avoiding storage/containers. The overall maintenance of piped schemes can be improved to minimize the influx of bacteria and other contaminants in the water.

The significant percentage of consumers satisfied and neutral to their prior water supply showed the need to adopt a demand-responsive approach to identify communities for inclusion in sector programs and making this approach standard.

The policy of improving cost effectiveness by identifying means to implement projects that meet basic needs at lower costs may not be a good idea for rural drinking water. This is because not all technologies are amenable to piped house connections and concentration on low-cost rainwater harvesting and other non-mechanized technologies has shown continuous deterioration of water quality making the water unsuitable for domestic use.

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