

**“Increasing Quantity of Water: Perspectives from Rural Households in
Uganda”**

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Abstract

Community involvement, low-tech, and affordability are some of the important concepts in increasing water-access to the rural poor. This study examines water-collection behavior of households in a rural area without piped-water in the Mbale district, Uganda. It tests for the determinants of water quantity available at the household level and suggests measures to increase water quantity. The result of multiple regression analysis showed that the amount of water per capita per day increased by 0.86 liters (11% of the current average water quantity of 7.87 liters) with the addition of one 20-liter jerry can to a household. If a household has a sheet-metal roof (facilitating rainwater collection) and also uses a bicycle to carry water, the amount of water per capita increased by 2.08 liters (26%), compared to not having both factors or having only one. This result implies that the amount of water at a household level can be increased by means other than constructing new water sources.

Keywords

water quantity, household, domestic water collection, low-tech, Uganda

1. Introduction

How to achieve the Millennium Development Goals (MDG) is currently of deep concern to the international community and various recommendations have been made by different researchers and organizations (Brown & Holcombe, 2004; Lane, 2004; Sachs, 2005). One of the Millennium Development Goals is halving the proportion of people without sustainable access to safe drinking-water by the year 2015 compared to the 1990 baseline. In sub-Saharan Africa, the population with access to safe water is estimated to have increased from 49% in 1990 to 58% in 2002 (WHO and UNICEF 2004). This increase can be attributed to the efforts of governments, donors, and the private sector in improving the public infrastructure and also in increased management efficiency (such as that described by Mugisha, Berg & Skilling, 2004). NGOs and local communities themselves are playing positive roles as well. However, there is still a long way to go to achieve the MDG.

Some of the recurrent recommendations that I will focus on in this paper are involvement of local community and appropriate technology. Cost compared to benefit is also an important aspect for policy makers (Hutton & Haller, 2004), as well as for the community members. Having these in mind, the purpose of this article is to draw attention to very inexpensive ways to expand water supply to rural villages involving households in the community.

The benefit of an expanded or new water supply is not only water quality but also quantity. The Joint Monitoring Programme (JMP) of WHO and UNICEF (2000) defines adequate access to water supply as “the availability of at least 20 liters per capita per day from an ‘improved’ source within one kilometer of the user’s dwelling.” However, the issue of water quantity per capita is addressed less often in interventions because of the difficulties in measuring performance improvement against a set goal. In terms of the reduction of water-related diseases, water quantity is more important than water quality (Esrey, Potash, Roberts & Shiff, 1991).

When we focus at the grass roots level, water quantity available to households can be increased by means other than adding new water points. The research reported here, based on 14 months of anthropological fieldwork in a rural agricultural area in Uganda, focuses on household behaviors and examines factors that determine the amount of water available to households. The observations are offered to promote debate within the policy community and to stimulate new perspectives to address what many view as a global challenge.

2. Research Method

Research Area

The research was conducted in Bugobero, a rural agricultural area in Mbale district, Uganda. Much of the district is sub-tropical with an average temperature of 24 degrees Celsius. There are two rainy seasons, and the annual rainfall averages 1191mm/year (NEMA, 1997; Rwabwoogo, 1997). With the relatively high rainfall, this hilly area seems lush at first glance. However, like the majority of rural African settlements, Bugobero lacks good access to safe water and has a high incidence of children's diarrhea. During the 1998 cholera epidemic in Uganda, Mbale had the highest prevalence of this water-borne diarrheal disease (Kiyonga, 1998). A national NGO, Mission: Moving Mountain (M:MM), and a government project called RUWASA (Rural Water and Sanitation) funded by DANIDA (a Danish donor) have since intervened to improve water sources (RUWASA, 1996; M:MM, 2000). These effect made the region ideal for studying the use of water since some households now had greater access than others.

Data Collection

As a first step, I selected 90 households randomly, 30 each from three villages in Bugobero sub-county which had varying degrees of access to water sources. I administered a household survey to assess the general characteristics of the population of my research area, including preliminary information on water and health.

For the next stage, I selected 50 households from the 90 households in the survey to visit monthly for monitoring. The sample size of 50 is small, but it was necessary to focus on a limited number of households in order to permit close monitoring and observation of each household. My two research assistants and I visited the selected households almost monthly for nine visits. Each monthly visit lasted for almost 3.5 hours at their household compounds. During our visits, we systematically observed water collection and water use behaviors of household members using a check sheet, and we asked a short set of questions about their water collection of the previous day (who went, which water source, how much water, and how it was carried). We also recorded our casual conversations with household members regarding water, which was later used for text analysis.

The combination of qualitative and quantitative data collection methods provided an ethnographic understanding of daily water use in households. It

also made it possible to conduct statistical analysis on the determinants of amount of water at the household level.

3. Results and Discussions

Water Collection and Water Use in Rural Households

Any person who has visited the countryside in sub-Saharan Africa has likely seen people carrying water along a road, or a crowd gathered around a water source; they are almost always women and children. Bugobero is no exception. In this research, women and children made 95.3% of the trips for fetching water (n= 1177). Children are valuable assets for fetching water, and start this chore as young as three years of age, carrying three to five liters. By the time they reach 13 years of age, children can carry, on average, the same amount of water as adults do (a full 20-liter “jerry can”). In fact, some children start carrying 20 liters at the age of ten.

A “Jerry can” is a hard plastic container with a capacity of approximately 20 liters (Figure 1), that is used most commonly in eastern Africa for fetching water and carrying it back home (Thompson, 2001). I could not confirm when jerry cans became so ubiquitous in eastern Uganda, but when White, Bradley and White (1972) conducted research in east Africa, tin buckets (*debe*), which hold 18 liters, were reported to be the favorite water container at all their study sites. The jerry cans used in households are usually recycled from cans that originally contained paraffin. In fact, it takes a while to get the smell of paraffin out of the can after you first purchase it. Purchasing a recycled jerry can is an investment for most households and does not occur very often. If a jerry can cracks, people try to mend it, and if the damage is more than a crack, people cut the jerry can in half and use the lower part as a basin. Each household possessed two to three of the 20-liter jerry cans and a few smaller size jerry cans that can be used for carrying water (Table 1). When adding up the total capacity of all the jerry cans used by each household, the average was 71.44 liters (sd=30.41), with a range of 26 to 163 liters.

Figure 1. Jerry cans at a protected spring

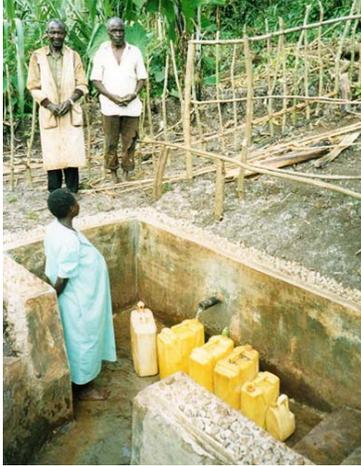


Table 1. Number of jerry cans possessed at each household

	Average	minimum	maximum	sd
20-litter jerry can	2.67	1	6	1.19
10-litter jerry can	1.06	0	4	1.03
5-litter jerry can	1.08	0	4	1.11
3-litter jerry can	0.82	0	6	1.04

In Bugobero, water in jerry cans is usually carried on the head. Bicycles are also used for carrying water, but not hand-drawn carts or domestic animals as used in other areas. When on foot, the average water carried on each trip was 18.1 liter, compared to 35.2 liter when using a bicycle (Table 2). However, bicycles are used only 12.9 % of all trips for water. In fact, women and girls use bicycles on just 3.1 % of their trips (Table 3). Although bicycles are expensive assets, it is not a taboo for women to ride a bicycle in Bugobero (In some parts of Uganda it is). Nevertheless, women's use of bicycle for carrying water is limited. "There is no bicycle as far as we are concerned," said one woman whose husband is often seen with a bicycle. "My husband would not let us use the bicycle just for fetching water." Yet, women are quite aware of the benefit of using bicycle for carrying water: "If I could use the bicycle, I could fetch enough water and can have more rest."

Table 2. Amount of water in each trip by walking and bicycle

	Walk	Bicycle
N of cases	912	143
Minimum	3 Liter	3 Liter

Maximum	30 Liter	70 Liter
Mean	18.13 Liter	35.34 Liter
Standard Dev.	5.099	13.557

Table 3. Mode of transportation by gender

	Female	Male	TOTAL
WALK	852 (76.3%)	121 (10.8%)	973 (87.1%)
BICYCLE	27 (2.4%)	117 (10.5%)	144 (12.9%)
TOTAL	879 (78.7%)	238 (21.3%)	1177 (100.0%)

Most households used multiple water sources. The sources available in Bugobero were boreholes, protected springs, hand-dug wells (un-protected), natural streams, and the collection of rainwater from roofs. There were various factors for deciding which water source to go to. The two most important criteria for selecting a water source are the season, and whether the water will be used for drinking or other domestic use. The rainy season did not always play a positive role by providing rainwater; for example, it caused some streams to get too full for people to cross, precluding them from getting to springs on the other side of the bank. The average distance from households to their choice of water sources was 1219 meters (sd=782), with the range of 27 meters to 5049 meters.

Rainwater was collected by all the households with sheet-metal roofs (corrugated, galvanized iron sheet; or also called GI sheet), although no household was equipped with a constructed water tank. Most households place buckets, cooking sauce pans or jerry cans under their roof when it starts raining. Only a few household had a 200-liter recycled metal drum under their roof – the maximum capacity for collecting and storing rainwater I observed. At the beginning of my research 25 of the 50 observed households had sheet-metal roofs. By the end of my research a year later, three households had constructed new houses and their roofs were changed to sheet metal. The rest of the households were thatched either with grass or banana-tree fiber and did not collect rainwater from their roofs. At times they collected rainwater from nearby kin or close friends if they are allowed to do so. But I also heard claims such as, “Some people don’t want you to collect rain water from their roof. They say ‘my husband refuses me to accept people collecting water from our roof.’”

The average amount of water per capita in a day was only 7.87 liters (sd=2.03). Water available per capita was calculated by the total amount of water brought to a household in a day divided by the total number of household members. People economize and re-use water at every possible turn. One young mother said, “Carrying water makes my body hurt. And if you fetch water like this, you

feel you shouldn't miss even a drop." As these words make clear, water carried into a household with much effort is used carefully. In fact, water used for one purpose is often reused for other purposes. The research found that the amount of water available at a household also affected the frequency of hand washing (Sugita, 2004). Even drinking less water was suggested as a strategy to save water when people did not have much water at home.

Determinants of Water quantity

Let us return to the initial question: How can one increase the amount of water available at a household level? Based on literature review (White et al. 1972; Thompson, 2001; Tumwine, 2002) and participant observations in Bugobero, the following eight factors were examined to identify the determinants of the amount of water available to the household per capita in a day.

- a. Distance between each household and its choice of water sources;
- b. Whether the household used a bicycle for water collection;
- c. Total volume of jerry cans possessed by the household;
- d. Total volume of water containers, for carrying and storing water;
- e. Whether the household has a sheet-metal roof;
- f. Whether it is rainy season or dry season;
- g. Total number of people in the household;
- h. The ratio of the number of people who fetch water in a household to the total number of household members

I conducted multiple regression analysis with the amount of water as the dependent variable. From the 50 households monitored approximately eight times each, only 272 observations were used in the analysis. The rest were dropped because data for one or more of the variables were missing or unreliable. In fitting models, a correlation that exists between observations belonging to the same household was incorporated. I used the PROC MIXED from SAS/STAT (SAS Institute Inc., 2002) with an autoregressive error structure, instead of a general linear model which assumes independence of observations. The estimated value for the correlation between consecutive observations within a household was 0.2024.

Various combinations of the explanatory variables and their interactions were tested, and the following variables remained in the model (p-value <0.1): *total number of people in a household*, *total capacity of jerry cans*, *type of roof*, *bicycle use*, and the interaction between *roof* and *bicycle*. The output is shown in Table 4. *Sheet-metal roof* and *bicycle use* were kept in the model despite their high p-value, because their interaction had a p-value <0.1.

Table 4. Independent variables in the multiple regression model

Effect	F	p-value
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Total number of people	19.05	<.0001
Jerry can total capacity	6.91	0.0091
Roof	2.47	0.1190
Bicycle	0.96	0.3275
Roof*Bicycle	3.11	0.0809

I further tested whether the differences between the intercept of “Roof=0, Bicycle=0” and the other three intercepts are statistically significant. Table 5 shows that only “Roof=1, Bicycle=1” (R1-B1) was different from the other three combinations ($p < 0.10$). In other words, the differences among R1-B0 (Roof 1, Bicycle 0), R0-B1 (Roof 0, Bicycle 1), R0-B0 (Roof 0, Bicycle 0) were not significant.

Table 5. Comparing Roof=0, Bicycle=0 with other combinations

	F	p-value
R1-B1 with R0-B0	3.17	0.0791
R0-B1 with R0-B0	0.25	0.6215
R1-B0 with R0-B0	0.01	0.9422

note: R=sheet-metal roof, B=bicycle use

In sum, the results using multiple regression analysis showed that the *total capacity of jerry cans* and the interaction of the factors *type of roof* and *bicycle use* had a positive effect on the amount of water per capita, while *total number of people in a household*, had a negative effect. The other factors were not significant statistically. More concretely, the amount of water per capita increased by 0.86 liters with an addition of one 20-liter jerry can to a household. This impact is considerable, when we note that the current average amount of water per capita is 7.87 liters.

If a household had a sheet-metal roof and also used a bicycle to carry water, the amount of water per capita increased by 2.08 liters, compared to not having both factors or having only one. Sheet-metal roofs apparently facilitated collection of rainwater. On the other hand, bicycle use helped in the collection of water from water sources. Adding only one of these features did not have an overall effect, probably because having a sheet-metal roof only increases rainwater collection at home, while bicycle use only facilitates water collection at water sources. With the several conditional changes for water collection between rainy and dry season, it appears that only having both a sheet-metal roof and bicycle use made

a difference in the average amount of water available per capita at each household.

On the other hand, the amount of water per person decreases by 0.65 liters, with an increase of one person in a household, controlling for other variables. This implies that the amount of water for common use in a household (such as cooking, washing plates, or even washing hands in the same basin) does not change proportionately with the increase in the number of household members. In other words, larger households may be economizing more in the use of water by sharing.

It may seem counter-intuitive that distance from a household to the water source did not show an effect on water quantity. However, as other research on water quantity illustrates, small changes in distance may not show significant effects on the amount of water consumption (Thompson, 2001); and the consumption-verses-travel time graph by Cairncross and Feachem (1993) shows a “plateau” where amount of consumption is unaffected by travel time. Yet, when the travel time is very short, water quantity increases significantly, while when the travel time is longer than 30 minutes, water quantity decreased.

4. Conclusion and Suggestions

The fact that the total capacity of jerry cans, sheet-metal roofs, and bicycle use have positive effects indicates that the amount of water available to households can be increased by measures other than the construction of new water supply systems. The benefits of pursuing such strategies include:

- i) They represent simple physical technologies (low-tech)
- ii) They are low-cost compared to most other water-supply interventions, and most likely require only a local institutional framework for promotion
- iii) The materials are already available to, used by, and desired by people
- iv) This gives direct-ownership to households and encourages self-help
- v) This can be targeted for the poorest of the poor

This observation is not meant to suggest that such Low-Tech and grassroots strategies can substitute for the construction or expansion of water points. However, as we consider how to allocate resources to meeting the MGDs, such strategies might be viewed as “gap-fillers” that promote better health outcomes and improve the quality of life. They warrant more attention from those who might otherwise favor “ribbon cutting ceremonies” over Low-Tech options.

Economic and social constraints may limit peoples’ access to physical technologies. As described earlier, purchasing a jerry can is an investment for a household. Sheet-metal roof or bicycles are even more expensive. But an institutional framework that reaches the grass-roots level can promote them, for

example, through micro-finance schemes. A model poverty eradication program by community-based organizations in Kerara, India, improved access to water by including credit schemes and micro-enterprise (supplying rainwater tanks) (Jose, 2003). The successful case of the Thai rainwater jar program was first facilitated by revolving funds provided by the government (Luong, 2002).

The international community tends to consider rainwater harvesting technology, which involves construction of large volume water tanks, expensive and thus biased towards the richer households. Hutton and Haller (2004) estimates the annual costs including initial investment and recurrent cost, for rainwater harvesting is \$ 3.62 per person, which is more than double of borehole \$1.70 per person. (Although in Latin America and the Caribbean, the numbers are reverse: \$2.66 for rainwater and \$ 4.07 for borehole). The cost and benefits can vary even within the same country depending on factors such as precipitation patterns, material costs, and access to alternative water sources (IRCSA, 2004). Designs for low-cost and low-tech storage tanks have been studied and promoted with success (Rees et al. 2000; Luong, 2002). However, none of the households in my study area had such water-tanks. Yet, a roof type that enables rainwater harvesting by itself showed an increase in water quantity at the household level. Promotion of impermeable roof material can also be perceived as a stepping stone for rainwater harvest programs, which takes such roofs as a precondition. Low-tech interventions can be in fact a interim strategy for a more efficient but higher investment technology (Verma, Tsepchal & Jose, 2004).

In addition, gender issues need to be considered. The benefit of rainwater harvesting, with or without tanks, not only increases the quantity of water available to households, but yields savings in time and energy for women and girls traveling to distant water sources. On the other hand, program designers should understand that buying a jerry can may be considered lower priority by male household heads and possessing bicycles does not assure its use for water collection. An innovation of a water cart using appropriate technology, for instance, could be more effective.

What is important is to examine the local context from the grassroots level. Jon Lane (2004) outlines other positive initiatives in Africa. By including very Low-Tech options in the policy tool kit, it is hoped that a range of solutions may be identified that alleviate the burden of carrying water and increase the quantity of water for the people.

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References

Brown, C. & Holcombe, A. (2004). In pursuit of the millennium development goals in water and sanitation. *Water Policy*, 6 (3), 263-66.

Cairncross, S. & Feachem, R. G. (1993). *Environmental health engineering in the tropics* (2nd ed). Chichester: Wiley.

Esrey, S.A., Potash, J.B., Roberts L., & Schiff, C. (1991). Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of the World Health Organization*, 69 (5), 609-621.

Hutton, G. & Haller, L. (2004). *Evaluation of the costs and benefits of water and sanitation improvements at the global level*. Geneva: World Health Organization.

International Rainwater Catchments System Association (IRCSA) (2004). *Factsheet: domestic roofwater harvesting for low income countries*.
<http://www.ircsa.org/factsheets/lowincome.htm>

Kiyonga, Hon. Dr. (1998). *Health policy statement 1998/1999*. Kampala, Uganda: Ministry of Health, Uganda.

Lane, J. (2004). Perspective: Positive experiences from Africa in water, sanitation and hygiene. *Water Policy*, 6 (2), 153-158.

Luong, T. V. (2002). *Harvesting the rain: A construction manual for cement rainwater jars and tanks*. Bangkok, Thailand: UNICEF, East Africa and the Pacific Regional Office.

Mission: Moving Mountains (M:MM) (2000). *Annual report 2000*. Mbale, Uganda: Mission: Moving Mountains.

Mugisha, S., Berg, S. V., & Skilling, H. (2004). Practical lessons for performance monitoring in low-income countries. *Water 21*, October, 54-56.

National Environment Management Authority (NEMA) (1997). *district state of the environment report: Mbale..* Kampala: NEMA.
<http://www.nemaug.org/DSOER/MBALE.pdf> (October 2001).

Rees, D. G., Nyakaana, S., & Thomas, T.H. (2000) *Very-low-cost roofwater harvesting in east Africa: Base on a feasibility study performed in the Great Lakes Region during May-July 2000*. Working Paper No. 55 September 2000. Warwick, UK: Development Technology Unit, University of Warwick.

Rural Water and Sanitation (RUWASA) (1996). *RUWASA II Inception report*. Mbale, Uganda: RUWASA.

Rwabwoogo, M. O., Compiled (1997). *Uganda districts information handbook*. 4th edition. Kampala: Fountain Publisher Ltd.

Sachs, J. D. (2005). *Investing in development: A practical plan to achieve the Millennium Development Goals, Overview*. New York: UNDP.

SAS Institute Inc. (2002). *SAS/STAT® Software, release 8.2*. Cary, North Carolina: SAS Institute Inc.

Sugita, E. W. (2004). *Domestic water use, hygiene behavior, and children's diarrhea in rural Uganda*. Ph.D. Dissertation. Gainesville, Florida: University of Florida

Thompson, J. (2001). *Drawers of water II: 30 years of change in domestic water use & environmental health in east Africa. Summary*. London : International Institute for Environment and Development.

Tumwine, J. K. (2002). *Drawers of water II: 30 years of change in domestic use & environmental health in east Africa. Uganda country study*. London : International Institute for Environment and Development.

Verma, S., Tsephalb, S. & Jose, T. (2004). Pepsee systems: grassroots innovation under groundwater stress. *Water Policy*, 6 (4), 303-18.

White, G. F, Bradley, D. J. & White, A. U. (1972). *Drawers of water: domestic water use in east Africa*. Chicago: University of Chicago Press.

WHO & UNICEF (2004). *Sub-Saharan Africa: water supply data*.
http://www.wssinfo.org/en/233_wat_africaS_en.html

WHO & UNICEF (2003). *The joint monitoring programme: definitions..*
http://www.wssinfo.org/en/122_definitions_en.html