Optimizing Rainwater Harvesting Installation in Kashongi, Uganda:

Sustainable Rural Water Supply, Collective Action and Institutions

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Abstract

Community-based water supply systems like Institutional Rainwater Harvesting (IRWH) are promising solutions to water supply in rural areas like Uganda. However, IRWH tank systems have been unsustainable in the long-term due to collective action failure, causing agencies to switch to less cost-effective systems. Current literature shows that local institutions are significant predictors of success in managing community-based resource, but little research has been done in the area of rural potable water supply. This study uses empirical research to investigate IRWH system sustainability, and its association with local institutions.

Focus groups, interviews and surveys were used to collect both qualitative and quantitative data in Kashongi sub-county, Uganda. The results show that villages in Kashongi sub-county have the potential to be self-reliant in sustaining their IRWH tank system. Institutions are associated with tank sustainability through two ways: financial sustainability and tank functionality. Least-squares regressions identified several key predictors of both financial sustainability and tank functionality. The study concludes that institutions are significant predictors of IRWH tank sustainability at multiple levels. Agencies implementing community-based water supply systems should either seek to foster suitable institutional arrangements within villages, or identify villages with characteristics of strong institutions in order to maximize their investment.

JEL classification: I30; Q5; Q25

Keywords: Rainwater harvesting; Rural water supply; Institutions; Collective action; Willingness to pay; Uganda

1. Introduction

Cost-effective, long-term water supply solutions are urgently needed in the developing world. Over a billion people lack access to clean drinking water, with severe economic and healthcare consequences. Rainwater harvesting (RWH) is emerging as one of the most viable solutions in rural regions, trumping alternatives such as gravity-flow systems, boreholes and hand-dug wells (Byomuhangi 2007).

RWH refers to the technique of intercepting rainfall and putting the captured water to a purposeful use, including irrigation, groundwater recharge, or potable use. Roofwater harvesting is a subset of rainwater harvesting, where rain is intercepted using the roof of a building. Gutters form a conveyance system to channel the water into a storage tank, and stored as clean, drinkable water for an extended period of time (Thomas and Martinson 2007, Doyle 2007). In this study, I will exclusively study institutional RWH as a type of roofwater harvesting.

Figure 1: IRWH tank at a primary school

Domestic RWH systems differ from institutional rainwater harvesting (IRWH) systems. The former serve only a single household while the latter is built within the compound of an establishment, such as a school, and can be accessed by the community. IRWH systems are superior to their domestic counterparts in rural areas for several reasons. Firstly, houses in

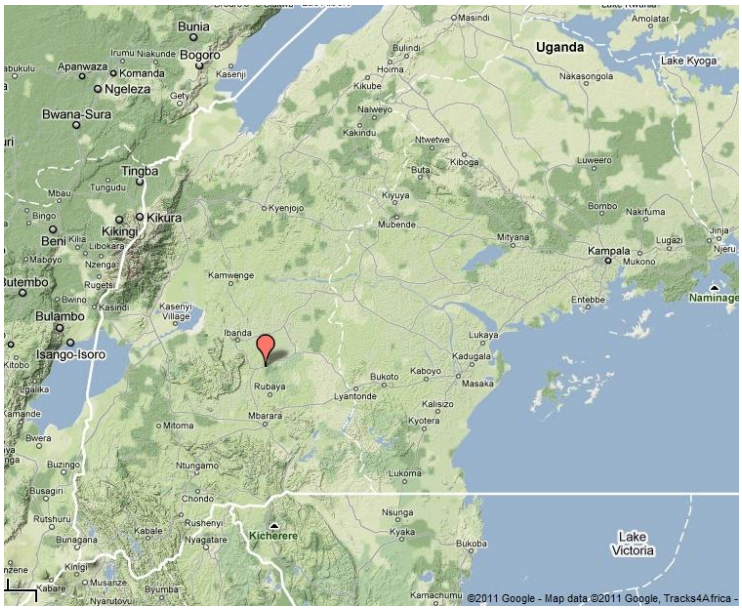
rural areas tend to have small roofs made with plant material, and are not optimal for collecting rainwater. IRWH tank systems do not face such structural challenges. Because they are located in establishments with larger roofs made with more suitable material such as zinc, they are far more efficient at harvesting rainwater. Also, because an IRWH tank can serve a whole community at a time rather than a household at a time, they have economies of scale that make them much more cost-effective for agencies to implement.

However, many IRWH projects fail after several years due to difficulties in management by the community, and as a result, many NGOs switch over to building domestic RWH systems as a second-best alternative (Thomas and Martinson 2007). This is a classic collective action failure often found in common pool resource (CPR) situations, and is a tremendous waste of limited resources for agencies involved in providing water supply systems to rural communities. Reddy et al. (2009) state that "the collective action framework is the most appropriate to study and understand common-pool resource situations such as traditional tank systems". I shall explore IRWH tank sustainability in Kashongi using this collective action framework in order to improve the effectiveness of new IRWH tank systems that are being built.

1.1. Project Background

Three organizations were crucial in the implementation of this project. The Progressive Health Partnership (PHP) is a student-led organization from Duke University, USA, which focuses on global health issues. Mayanja Memorial Hospital Foundation (MMHF) is an NGO based in Mbarara Town that has been prominent in providing health-related services such as HIV testing to the local community, since 2008. DukeEngage is a program under Duke University that focuses on giving students opportunities to provide service to communities around the world.

Figure 2: Map of Uganda showing Kashongi sub-county.



Picture taken from Google Maps

A team from PHP went to Southwest Uganda in the summer of 2009 to conduct a maternal health project. They found that community members in Kashongi almost unanimously complained of poor access to and quality of water as their most urgent need, frequently expressing the problem in terms of its detrimental effects on children. Children often bear the burden of carrying water for domestic use, spending several hours a day in drudgery and rendering them unable to go to school. The poor quality of water also greatly impacted health and mortality rates. PHP then applied for and received a $180,000 grant to build a system of over 70 Institutional Rainwater Harvesting (IRWH) tanks throughout Kashongi, with the partnership of MMHF. For the second year running, PHP brought a team of DukeEngage students to run the Rainwater Harvesting projects. The PHP team has conducted baseline surveys of more than 2000 randomly sampled households in Kashongi, *E. coli*. and coliform tests of household and water source samples, and focus groups with the community. The team also ran a water and sanitation education campaign.

Various agencies previously built IRWH tank systems in Kashongi, and a number of them had quickly deteriorated within a few years due to a lack of management, funding, and

maintenance, despite the huge improvements they had brought to the community. There is a need to investigate the factors associated with this failure of collective action, so as to ensure that the investment of the PHP-MMHF IRWH tank system has a lasting impact on the community. In the summer of 2010, I was given a Service Opportunities in Leadership (SOL) grant within the Hart Leadership Program at Duke University to conduct a field study on IRWH tank sustainability. I did so with the help of five locally-hired surveyors contacted through MMHF. Data from these tank sustainability surveys were used in this study.

This study will use the qualitative data gathered during field research and information from the body of literature to create a theoretical framework of the association between institutional strength and the sustainability of existing IRWH systems within Kashongi Sub-county. Then, I will compare the quantitative data obtained from two separate surveys against the hypotheses I formed.

I plan for this study's findings to be meaningful a few ways. Firstly, I will investigate if villagers are able to be financially self-sufficient in terms of paying for tank maintenance, and what factors predict willingness to pay. If they are able to support the tank financially, this relieves a financial burden from MMHF. Secondly, I will determine which factors correlate with the sustainability of the IRWH tank system, especially factors identifying the presence of collective action and institutions. I intend to find out if and how local institutions play in role in tank sustainability. Also, I will use findings from literature, as well as qualitative and quantitative data collected in this study to examine how external agencies can play a constructive role. Hopefully, these findings can be translated to help agencies in other regions of the world make better decisions concerning the implementation of rainwater harvesting systems.

The study is organized into the following sections. Section Two is a literature review of existing research relevant to my study. Section Three is a description of my theoretical framework. Section Four is a description of the data, and the methods used to collect it. Section Five is an explanation of the derivation and composition of the institutional strength indices. Section Six is a presentation of the results, and a discussion of the implications. Section Seven consists of

recommendations I make to agencies involved in IRWH. Section Eight presents the conclusions.

2. Literature Review

Collective action in community-based natural resource management has been extensively studied, and there is broad agreement in the literature on the four factors that influence it. Matta and Alavalapati (2006) state that they are: 1. Attributes of the resource, 2. Attributes of the management group, 3. Attributes of institutional arrangements and 4. External influences. Heltberg (2001) backs this up empirically, demonstrating that resource scarcity, size of user group, level of development and prior experience in the village with institutional cooperation are positive and significant determinants of collective action. Markelova et al. (2008), Bouma et al. (2006) and Hossain et al. (2009) show that community organization serves to build commitment and trust between participants in the presence of significant externalities within rural natural resource markets.

The association of institutions on collective action in rural communities is widely explored in the body of theoretical and empirical literature. In his seminal book *Village Republics*, Wade (1988) argues that village-level institutions such as councils form in response to environmental circumstances, such as risk and resource scarcity, and thus are a result of collective action. Bouma et al. (2006) finds a link in the opposite direction, proposing that collective action efforts are successful in the short-run, but without the presence of local institutions to coordinate long-run investment, system sustainability is not viable. This is because there is a poor, non-linear relationship between resource scarcity and cooperation between individuals in a community, in contrast to Wade's hypothesis. Meinzen-Dick (2007) also finds evidence that water scarcity is generally correlated with increased management intensity, but conflicts grow and coordination breaks down when scarcity becomes excessive.

Speelman et al. (2010) hypothesize that institutions are important in several ways: they create improvements in efficiency of exploitation of the natural resource, enforce cost recovery, and provide channels of communication between participants. Low institutional trust causes people to value each of these factors less, and therefore make them less willing to contribute financially and to participate in collective action. There is an added level of complexity

introduced, because institutional effectiveness is not separate from institutional trust. I will build on these hypotheses regarding institutional trust and effectiveness in this study.

Heltberg (2001) uses an IV regression in which the dependent variable is the log of a Forest Degradation Index that he creates. He shows that the presence of grouped formal or informal management institutions as a dummy variable is a strongly significant predictor, with a coefficient of -0.41. In comparison, the dependent variable has a mean value of 1.90.

The influence of institutions and collective action also has widespread acknowledgement in the context of community-based rainwater harvesting systems. Janakarajan (1993) states that institutional factors “have a direct bearing on the functioning of tank irrigation”, and often interact with physical and technical factors to influence tank sustainability. Reddy et al. (2009) cites Andhra Pradesh, India, where indigenous practices called *kudimaramat* and *dasabandam* were widely implemented, and led to the flourishing of RWH irrigation systems for millennia. In Sub-Saharan Africa, increasing water scarcity has led to conflicts over communal water sources between clans. Traditional institutions helped promote peaceful coexistence, and prevented escalation (Ngigi 2003).

External institutions (referred to as “agencies” for the rest of the study) can also help foster collective action to different extents. Bouma et al. (2006) separate different levels and types of institutions in their analysis. They show that NGO investment in a community watershed development substantially increases the likelihood of household contribution to soil and water conservation efforts. They attribute this effect to NGO interventions increasing investment in community organizations. Government intervention, however, does not have a significant effect. This supports the finding that top-down implementation approaches are not as successful, compared to bottom-up NGO approaches.

The correlation of institutions with willingness to pay for access to water through collective action mechanisms is also well documented. Speelman et al. (2010) explore the willingness of farmers to pay to improve their irrigation water rights system as a dependent variable. They empirically demonstrate that the level of institutional trust influences the coefficient of all

significant correlates, such as the duration and quality of water rights title. Polyzou et al. (2010) support this finding in an urban study. Institutional trust was found to be positive and significantly correlated with WTP to improve piped water supply. Average WTP (excluding protest responses) was 10.38 euros. Respondents that indicated trust in the relevant institutions were willing to pay 1.33 euros more than respondents who did not. Polyzou et al. cite literature from Kim (2005) and Beierle et al. (2002) that connects an individual's WTP with their perception of institutional efficiency in resource management. Polyzou et al. also separate social capital from institutional trust, and found that its association with WTP to be positive and significant, a finding that I will test in this study.

Reddy (1999) finds that failure of government policies and institutions play the largest role in rural water shortages, rather than environmental limitations or financial inability on the part of the residents. Both Reddy and Sturm et al. (2009) demonstrate that villages are willing and able to pay for the maintenance of community-based water supply sources in a sustainable manner. This echoes my findings for the villages in Kashongi sub-county.

Despite the significant literature on community-based natural resource management, and especially RWH irrigation, there is little literature on smaller-scale potable IRWH tank systems. Although these RWH systems have significant differences from the IRWH tank systems I will be studying, much of the findings can be usefully translated. The following table summarizes the studies that are most relevant, and shows important predictors:

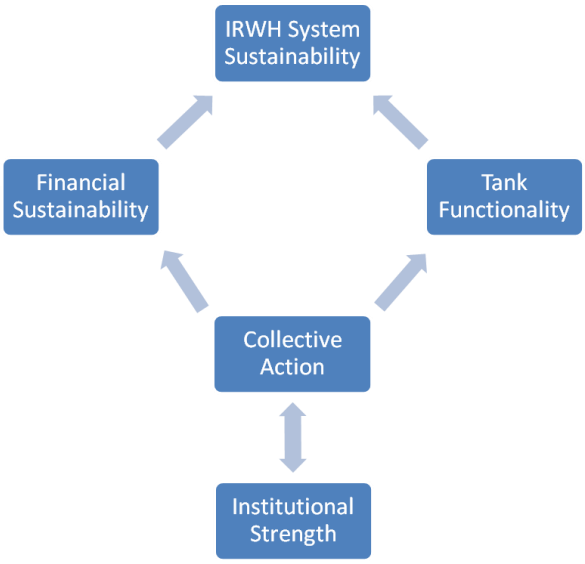
Table 1. Literature Summary Chart

Authors	Year	Sample	Location	Type of System	Main Focus	Findings/ predictors
Bouma	2006	22 villages, 679 households	Watershed areas in Andhra Pradesh, Karnataka, Rajasthan and Maharastra, India.	Watershed development through soil and water conservation.	Effectiveness of community participation on soil and water conservation efforts.	Location, rainfall scarcity, access to irrigation, NGO investment, income inequality, and amount of benefits from collective action are significant predictors of household willingness to invest.
Heltberg	2001	37 villages, 180 households	Sariska Tiger Reserve, Rajasthan, India	Collective Forest Management	How institutions correlate with collective action and resource degradation	Population, level of development and prior institutional experience in village are significant. Presence of formal or informal institutions predicts extent of forest degradation
Reddy	2009	3 villages, 150 households	Andhra Pradesh, India	Community-based RWH irrigation system	Impact of tank restoration	The impact of tank restoration is partially influenced by the presence of institutions.
Speelman	2010	134 farms	Limpopo province, South Africa	Community-based RWH irrigation system	WTP for irrigation, water rights systems and institutional trust.	Improvements in market transfer, income and title price are significant predictors of WTP. Level of institutional trust influences coefficients of predictors.
Reddy	1999	6 villages, 92 households	Rajasthan, India	Various types of rural water supply	WTP for potable water. Institutions and rural water supply.	Farm size, annual income, and village are significant predictors of WTP.

3. Theoretical Framework

3.1. Thesis Diagram

Figure 3. Association between IRWH sustainability, collective action and institutions



In this study, I identify two components of tank sustainability: financial sustainability and tank functionality. These two components are analyzed within the framework of collective action, and I shall investigate how collective action issues relate to each one of them. I will also explore the association of local institutions with collective action. Since we have determined that local institutions are shaped by collective action, and also help to preserve and enhance collective action, I shall pursue both lines of thinking.

3.2. Definition of Sustainability

Sustainability in this context is defined by the IRWH tank system's continued ability to reliably deliver clean drinking water to the target community, through financial and physical maintenance support from the community, and with as little intervention from external sources as possible.

3.2.1. Financial Sustainability

A large part of the IRWH system's sustainability is determined by the residents' willingness to pay (WTP) for financial support of the system. We use 7% of the upfront building costs as a benchmark for the required yearly maintenance, as widely recommended (Thomas and Martinson 2007, 1-160). If the sum of what residents in a community are willing to pay matches or exceeds this figure, then the IRWH system is deemed to be at least financially sustainable.

I will investigate the factors that predict willingness to pay. Such factors include household characteristics such as income, distance travelled to current water source, current perceived water quality and number of existing children who can help carry water. It also involves other factors such as the way water will be distributed from the tank, institutional trust, and level of social capital (Hardy and Koontz 2009, 393; Polyzou et al. 2011, 74-80; Speelman et al. 2009, 341-352).

3.2.2. Tank Functionality

Even when financial sustainability is achieved, the physical sustainability of the tank is not guaranteed. Actual tank functionality is measured by two dependent variables: the likelihood of the tank breaking down, and reliability (number of days the tank has water in a year). Factors that are associated include the type of tank, the quality of tank management, the availability of repair contractors, and the number of residents using the tank. Focus group findings were used to identify likely explanatory variables, and then these were regressed on the likelihood of a tank being broken.

3.3. Institutions

In this study, I adapt North's (1991) influential work on institutions. I define institutions as rules, norms, organizations, monitoring and sanctioning founded for systematically carrying out a specific purpose, and shapes the actions and expectations of individuals. If collective action is a pathway collaboratively decided upon by a community to help them reach an end goal, local institutions are the archways built over the pathway. They provide constraints on individuals' choice sets such that cooperation is the best option, both for individual and community outcomes.

There are various institutions in Kashongi sub-county, but for the purposes of this study I shall group them into five categories for meaningful examination. The first level is the local sub-county government, which is an arm of the district government overseeing the general operations of the region. The second level consists of the village local council (LC1), which manages the daily running of the village's affairs. They have the power to enforce rules, such as implementing a fine. The third level consists of the water-users associations (WUAs) that take care of all water sources that the village uses. Specific water-user committees (WUCs) belong to the fourth level, and they are responsible for a single water source. The most frequently-used example in this study would be tank committees, formed by the establishments that house the IRWH tanks. The last type of institution I will consider are informal arrangements within the village, such as cooperatives or health funds. They represent the "institutional capital" that the village possesses.

3.4. Model of Utility

We construct a Cobb-Douglas utility function for a household *i* in order to provide intuition into how it may decide its tradeoffs in a scenario after the implementation of an IRWH tank.

(1) $U_{i,j} = C_{i,j}^{\alpha}\, Uw(F_k)_{i,k}^{(1-\alpha)}\, \varepsilon_{i,j,k}$

The utility $U_{i,j}$ that a household *i* located in village *j* is assumed to be determined by its consumption of a composite private good represented by $C_{i,j,}^{\alpha}$ and by the individual consumption of water from the tank, represented by $Uw_{i,k}^{(1-\alpha)}$. $Uw_{i,k}^{(1-\alpha)}$ is a function of tank functionality, indexed by establishment *k.* I include an unobserved error term $\varepsilon_{i,j,k}$. The household maximizes its utility, subject to the budget constraint:

(2) $S_{i,t} = I_i - C_{i,j} - Y_{i,j} + (1 + r_j)S_0$

I find a household's difference in savings across a time period, $S_{i,t} - (1 + r_j)S_0$, as consumption $C_{i,j}$and amount paid for tank maintenance $Y_{i,j}$ subtracted from income I_i. Daily breadwinner income is used as a proxy for household income. I assume that the household regards the WTP amount they state on the survey $Y_{i,j}$ as the amount that they expect will be collected from them. Interest rate r_j varies across villages *j*. I elaborate the tradeoffs between time spent for income generation T_h and water collection T_w:

(3) $I_i = \omega T_h = \omega(T - T_w - T_l)$

Wage rate ω is calculated by dividing breadwinner income by 8, as the survey questionnaire asked respondents to assume that they worked 8 hours a day. Total time available T is the sum of time spent generating income T_h, time spent collecting water T_w and time spent for leisure T_l.

The utility a household gains from water collection from a tank is a piecewise function. This is because when tank functionality goes below a certain threshold level F_k^*, it stops delivering

water. An example of this is when a tap or gutter is broken, and the tank delivers no water whatsoever. However, further investments into a tank beyond the threshold level improve the quality of the water produced.

(4) $Uw(F_k)_{i,j} = \begin{cases} Uw \; if \; F_k > F_k^* \\ 0 \; if \; F_k < F_k^* \end{cases}$

Derivation of the first order conditions from Equations (1) and (2) gives us the following reduced-form equations:

(5) $\frac{\partial U_{i,j}}{\partial Yi,j} = \pi_1 \frac{\partial I_i}{\partial Y_{i,j}} + \pi_2 \frac{\partial Uw_{i,k}}{\partial Y_{i,j}}$ or

(6) $\frac{\partial U_{i,j}}{\partial Yi,j} = \pi_1 \omega \frac{\partial T_w}{\partial Y_{i,j}} + \pi_2 \frac{\partial Uw_{i,k}}{\partial F_k} \frac{\partial F_k}{\partial Y_{i,j}}$

The tradeoffs that a household has to make are clear. For the marginal cost of paying for tank maintenance, it has the marginal benefits of time saved from collecting water (in turn increasing income proportionally by wage rate), and improvements in water quality. Informally, we would thus expect households to mentally take these factors into consideration as they make a decision on the amount they would be willing to pay during the survey.

Equation (6) also raises another interesting question: how does tank functionality correlate with the amount of money paid to maintain it?

A condition that has to be fulfilled in order for the tank to be sustainable is that the total sum of money collected from each villager has to be greater than a certain threshold level Υ_j^*. However, the strength of the institution also determines the effectiveness of the money used. A certain village's institution might be corrupt, or simply ineffective, rendering the money paid less effective. The higher institutional strength is, the lower the threshold needs to be.

(7) $\sum_i^n Y = \Upsilon_j > \Upsilon_j^* \; \frac{institutional \; strength}{\max institutional \; strength}$

In equation (7), we thus set up a decay value for the money collected based on the strength of the local institutions. Another question is whether the elasticity of total money collected on tank functionality is a function of institutional strength, represented in the following equation:

$$(8)\ {}^{\frac{\partial F_k}{\partial \Upsilon}}\Big/_{\partial(institutional\ strength)} > 0$$

However, the current IRWH tanks that I am investigating do not actively collect money from the population for tank maintenance. Thus, this line of research can only occur after the MMHF tanks have been built. It will be meaningful to pursue this further research during a trial period whereby local institutions collect tank maintenance fees from their serviced communities.

While I am unable to provide the entire model of general equilibrium since information on the price of water is not available, this model is useful in providing a sketch of the decision-making process. This model provides the motivation to run least-squares regressions for WTP and tank functionality in the next section. Equations (5) and (6) give the impetus to include income, improvements in water quality, and time saved from collecting water as variables in the least-squares regression for WTP.

3.5. Model of Willingness to Pay

For current RWH tank users *i* located in village *j*, we consider the model:

(9) $Y_{i,j} = \beta_0 + \beta_1 X_{1i,j} + \beta_2 X_{2i,j} + \beta_3 X_{3i,j} + \beta_4 X_{4i,j} + \varepsilon_{i,j}$

Dependent Variable

1. Willingness to Pay for tank maintenance

Independent Variables with expected coefficient signs

1. $X_{1i,j}$**: Household Characteristic Variables**
    a. Household income (+)
    b. Number of household members (+)
    c. Dummies for types of alternate water sources used
2. $X_{2i,j}$**: RWH Tank Impact Variables**
    a. Change in perceived water quality (+)
    b. Change in time spent collecting water (+)
    c. Other benefits experienced (+)
3. $X_{3i,j}$**: Institutional Trust Variable**
    a. Effectiveness of village-level water-user committees (+/-)
4. $X_{4i,j}$**: Social Capital Variable**
    a. Reduction in crime experienced when travelling to the tank compared to previous water source (+)

3.5.1. Model of Tank Functionality

(10) $F_k = \beta_0 + \beta_1 X_{1k} + \beta_2 X_{2k} + \beta_3 X_{3k} + \beta_4 X_{4j} + \varepsilon_{i,j,k}$

Dependent Variables

2. Frequency of tank breakage
3. Number of days dry in a year

Independent Variables with expected coefficient signs

1. X_{1k}**: Establishment Characteristic Variables**
    a. Type of establishment
    b. Type of tank
2. X_{2k}**: Tank Committee Institutional Strength Variables**
    a. Committee strength indices (+)
3. X_{3k}**: Water Demand Management Variables**
    a. Method of water demand management (+)
4. X_{4j}**: Parish Institutional Strength Variables**
    a. Effectiveness of parish-level water committees (+)

4. Data

The research consisted of three data collection methods:

4.1. Focus groups

Kashongi Sub-County is split into 7 parishes, with each parish consisting of several villages. 5 focus groups were conducted with the intention to discern information regarding the current management of water sources in Kashongi. Community Volunteer Counselors, who are community organizers, were paid to recruit participants from their respective parishes. They were asked to form focus groups with participants from the same parish, but from different villages. Each focus group consisted of 5 participants. Some focus groups consisted of general community members, others of different water-user associations (WUAs), and the rest of a mix of both.

WUAs, as previously mentioned in the section 3.3, are organized at village and parish level. They manage various water sources, such as communal dams, boreholes and several existing tanks. They collect funds for maintenance, if necessary, handle complaints from the community, and decide how water is distributed. They are mostly elected, with some members of committees being community leaders.

Table 2. Composition Of Focus Groups From Each Parish

Parish	Focus Group Participants
Rwenjubu	Participants in the Rwenjubu Parish focus group were all general community members, none of whom sit on WUAs
Kitabo	The focus group consists of a mix of general community members and WUA members, including one who sits on a primary school tank committee.
Byanamira	Two of the participants are general community members, while 3 of them are on dam committees. 1 amongst the 3 sits on a school tank committee.
Kitura	Participants in this focus group are all members of different WUAs from Kitura Parish.
Mooya	Participants in this focus group are all members of different WUAs from Kitura Parish.

Five of the seven parishes were picked for focus groups due to cost considerations. After consultation with the project manager from MMHF, Rwenjubu, Kitabo, Byanamira, Kitura and Mooya were chosen, while Rwanyangwe and Rwemamba were left out due to their distance and low population. This could have impacted the answers received. Although the population of Rwanyangwe is similar to those in the other parishes, the population of Rwemamba consists of a tribe of herdsmen that are relatively wealthy due to their assets in cattle.

Focus groups from the first 3 parishes met us in the sub-county meeting hall after local primaries were held. For the latter 2 parishes, we met them in parish public buildings designated by their respective CVCs. In each focus group, it was ensured that no one else besides the participants were around so that each group could feel free to voice their opinions. Despite this preparation, the presence of other participants in the focus group still influenced what they said. An oral consent script was read, and consent obtained before the focus group began. Each focus group member was informed at the time of recruitment that they would be compensated for travel expenses at the end of the focus group. The focus group discussion was recorded on an audio device, and transcribed afterward. All names and contact numbers were recorded in a document located in the premises of MMHF.

4.2. Interviews with Key Informants

Interviews were held with key informants that held important and relevant information. They were contacted through the phone (the NGOs through email), and informed beforehand of the nature of the interview. The key informants included:

a. **NGOs involved in Institutional Rainwater Harvesting (IRWH) projects.**

The African Community Technical Services, and the Diocese of Kigezi Water and Sanitation Program.

b. **Sub-County Chief, Kashongi Sub-County**

c. **Chairperson of Local Council 1 and Councilor of Local Council 3, Byembogo Village**

Byembogo village is hailed as the Model Village in Kashongi. Groups of villagers were organized to build tanks collectively, where villagers would pool their resources to build tanks

on their houses in turns. They would share the tanks in the meantime, thus this arrangement has some resemblance to an IRWH system.

d. RWH Tank Contractor

4.3. Surveys of Existing Institutions with Tanks (Tank Holders)

Key informants that owned IRWH tanks in their premises were identified. These included school head teachers, church leaders, health workers, and other public officials. They were surveyed regarding tank characteristics, management of the tanks, and demand management of the water. Several public tank holders that were not included in the PHP mapping exercise were identified, and surveyed. Furthermore, several private tank owners were identified and surveyed as well. They were pointed out by CVCs and several respondents in the household survey.

All known tank holders in the villages visited were surveyed, as well as tank holders identified in the PHP water-source mapping exercise. Thus, all identified tank holders were included, with a small possibility that there were tanks in villages not visited and not covered by the PHP mapping exercise. A total of 37 tank holders were interviewed. The data was transformed such that tank holders with multiple tanks were duplicated according to the number within the establishment. In this way, the points of observation were tanks rather than establishments. Thus, 53 tanks were observed. Every tank holder had access to a mobile phone, but few had access to email. They were informed that they could contact their parish-based CVCs at any point in time, who would put them contact with MMHF in case of any further questions.

4.4. Household Surveys

PHP conducted a baseline survey of more than 2000 households regarding their financial, water and sanitation situation. From this baseline survey, 81 households self-identified as using RWH tanks that were located outside of their household during either the dry or rainy season. Such households were assumed to use water from either IRWH tanks or from neighbors. A list of these households was created, and included in a new round of surveys designed to specifically investigate the sustainability of IRWH systems. Data from this round of sustainability surveys is used in this study. However, when actually surveyed in the

sustainability round, 41 of them indicated that they had never used IRWH tanks before. It is unclear why the discrepancy had arisen, and I chose to keep them within the data. In another set of households, CVCs were mobilized to identify additional households in their respective parishes who used RWH tanks located in public buildings, or in a neighbor's residence. In these surveys, households were either surveyed in their homes, or the household head was invited by the CVC to be surveyed in public buildings located in their village, or in a neighboring village. The latter group would be compensated for travel. Also, a small number of respondents were pointed out by owners of tanks, and surveyed in their village trading centers.

A total of 116 households were surveyed. The survey team tried to contact about five more households, but there was no adult at home to take the survey. One home was left out because it was too remote.

Table 3. Breakdown of Household Survey Sample Selection Process

Selection Process	Survey Location	Number
Self-identified as using external RWH tanks in PHP baseline survey	In their homes, or in a public building	65
CVCs identified RWH tank users in their respective parishes	In a public building.	51
Identified by village tank owners	Village Trading Center.	

Only 65 out of the 81 households that self-identified as using IRWH from the PHP baseline survey are included in the data. Some household heads were not at home when the surveyors came, and thus they were not interviewed in the second round. Several participants in the sustainability survey did not self-identify as using IRWH in the PHP baseline survey, but had participated in it. In total, 70 households are RWH users, while 46 households are not.

4.4.1. Estimation of WTP for Maintenance of the Tank

Survey data from the household and tank holder surveys were analyzed to investigate which factors are correlated with willingness to pay for tank maintenance, and to what extent. A Contingent Valuation Method (CVM) was used to judge the resident's willingness to pay (WTP). This technique is commonly used in the literature to gauge WTP for water (Quiggin 1998, Bronx et al. 2003, Belluzzo 2010, Peters et al. 2010). Respondents are asked for their WTP

contingent on a certain scenario given to them. For residents who were currently using a RWH tank, they were asked how much they would be willing to pay for the maintenance of the RWH tank per year, given that if they did so, the tank would continue functioning and they would be able to draw water from it. For residents who were currently not using a RWH tank of any sort, they were asked how much they would be willing to contribute to the yearly maintenance of a tank, in the hypothetical situation that PHP decided to build a tank in their village that they could access.

No mention was made of how much their neighbors would be contributing, and they were not told how much water they would be able to draw. In the event that they asked for the amount of water they could draw, they were told that they would be able to access an equal amount as their neighbors. It was assumed that respondents had roughly homogenous perceptions of tank water quality, and thus WTP did not depend on water quality. This assumption is backed up by findings from the survey.

The respondent was asked if they were willing to pay. If they said yes, they were asked to state the initial amount they were willing to pay, and then the amount was increased 50 UGX at a time until they were unwilling to pay. The last amount stated that they were willing to pay was recorded. A plan for the starting amount to be randomized was scrapped because of the difficulty of implementation.

There were several survey forms with non-response errors. A few were item non-response, when the respondent did not answer a key question, and the rest were protest non-response. Bronx et al. terms non-responses protest when the respondent’s answer was not valid for a certain reason. This may bias the findings.

5. Creation of Institutional Strength Indices

5.1. Principal Component Analysis and Factor Analysis

There are several possible indicators for institutional strength within a village. The first would be how effective are village-level water-user associations (WUAs) are in solving water source problems. Another would be the extent to which the village is involved in institutional arrangements that provides benefits to the community, or in other words the institutional capital of the village. This includes savings cooperatives or village townhouse meetings.

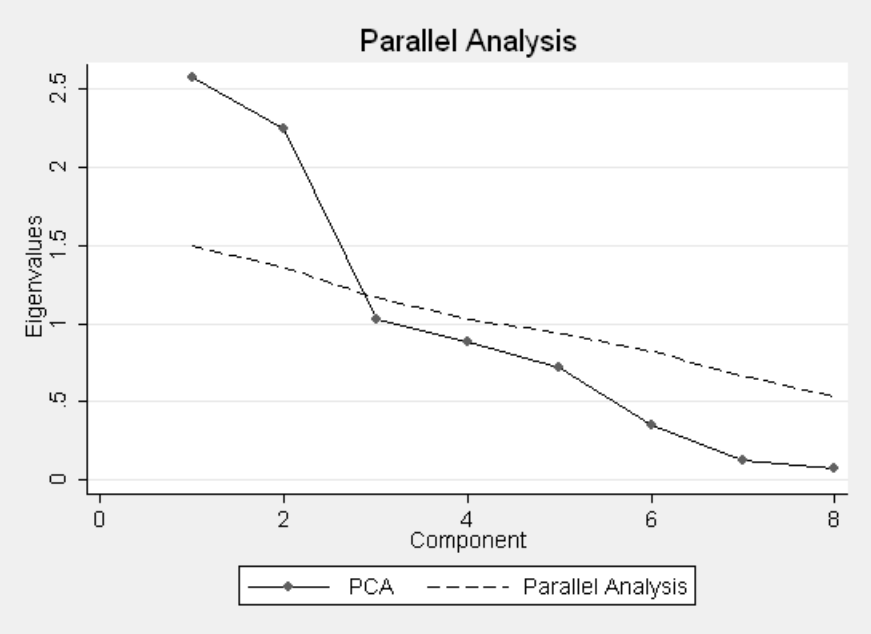
How, then, should institutional strength in a village be measured? We could assign equal weights to each of the variables in creating an index of institutional strength, but this is arbitrary and not empirically grounded. Instead, I use Principal Component Analysis (PCA) and Factor Analysis (FA). PCA/FA provides weights that are determined statistically, and are shown in a wide body of literature to be robust against alternative measures.

PCA is a widely-used technique developed by Filmer and Pritchett (2001). PCA extracts a common denominator from a set of variables, and uses this information to determine the weights required for an index. PCA is generally used in the literature to construct asset indices as an alternate measure of household wealth as compared to income (Vyas 2006). In this study, I use PCA to create an index for how an individual perceives institutional strength within his/her village based on his/her responses. Another commonly used approach that yields similar results is FA. The difference is that PCA is preferred for data reduction, while FA is preferred for structure detection. I include results from both in the appendix section.

I use PCA and FA to extract the principal components/factors (I will refer to both of them as factors from this point on) from a set of suitable variables that describe institutional strength. The correlations between the variables and the factors are called loadings. For FA, I perform a varimax rotation to obtain a clearer pattern of loading as commonly recommended. An average score for perceived village institutional strength is assigned for each, with the mean score standardized to 0.

Parallel analysis is used to determine the number of components that should be retained (Bruin 2006). In both WTP and tank functionality institutional strength indices, parallel analysis suggested that two components should be included. This is supported by examining the eigenvalues of the components, both of which have values above 1. Thus, they should be retained according to the Kaiser criterion. For more details on the procedure, refer to the Technical Appendix.

Figure 4. Parallel Analysis



We see that eigenvalues from the parallel analysis are lower than from PCA until they intersect before three components are used. Thus, two components should be included.

5.2. Measures of Institutional Strength

For the WTP regression, I employed three measures of institutional strength. The first is WUA effectiveness, which measures whether they managed to solve water problems that villagers approach them with. The second and third measures are indices created by PCA. The second index is a measure of overall WUA strength (effectiveness, approachability, helpfulness), while the third index measures institutional capital within the village (presence of village meetings, cooperatives and health funds). More details about the weightings can be found in tables 13-16 in the Technical Appendix.

In a similar vein, I created indices for the institutional strength of an individual tank committee based on the respondent's answers for the tank holder survey. I use FA in this instance for structure detection. I find that the first index, the tank committee involvement index, is primarily comprised of variables that measure how far the committee goes beyond its regular duties. The second index, which I will term the night watchman index, measures for the presence of a night watchman on the tank committee and his associated duties. From qualitative data gathered during interviews, this includes water distribution during the evening and security at night. Comparisons between the results obtained using PCA and FA are provided in tables 18 and 19 in the Technical Appendix.

A parish-level institutional strength index was also created. I used all respondents dataset (115 observations), and included 3 measures of institutional strength (WUA effectiveness, WUA effectiveness index, Institutional capital index). I then averaged institutional strength by parish using collapse (mean) by parish command, and merged this into tank holder data. I found that all 3 measures had similar findings. There was high correlation between WUA effectiveness and WUA institutional index at 0.94. I decided to use WUA effectiveness as it was the most basic.

6. Results

6.1. Tank holder Survey Summary Statistics

About 70% of the existing tanks were located in schools, due to government programs. Roughly 20% of the tanks were in private establishments (homes and shops), 5% in government-owned buildings, and 5% in religious buildings. A third of respondents were from Rwenjubu parish, the parish closest to the sub-county center, while the other respondents were relatively evenly distributed across the remaining 6 parishes. The private tanks in Byembogo (Rwenjubu Parish), where ACORD chose to build its tanks, were group tanks located in homes, and were usually shared by several households. The private tanks located outside Byembogo were commercial tanks, where the owner would sell water from the tank to other community members.

Figure 5. Survey Respondent Characteristics

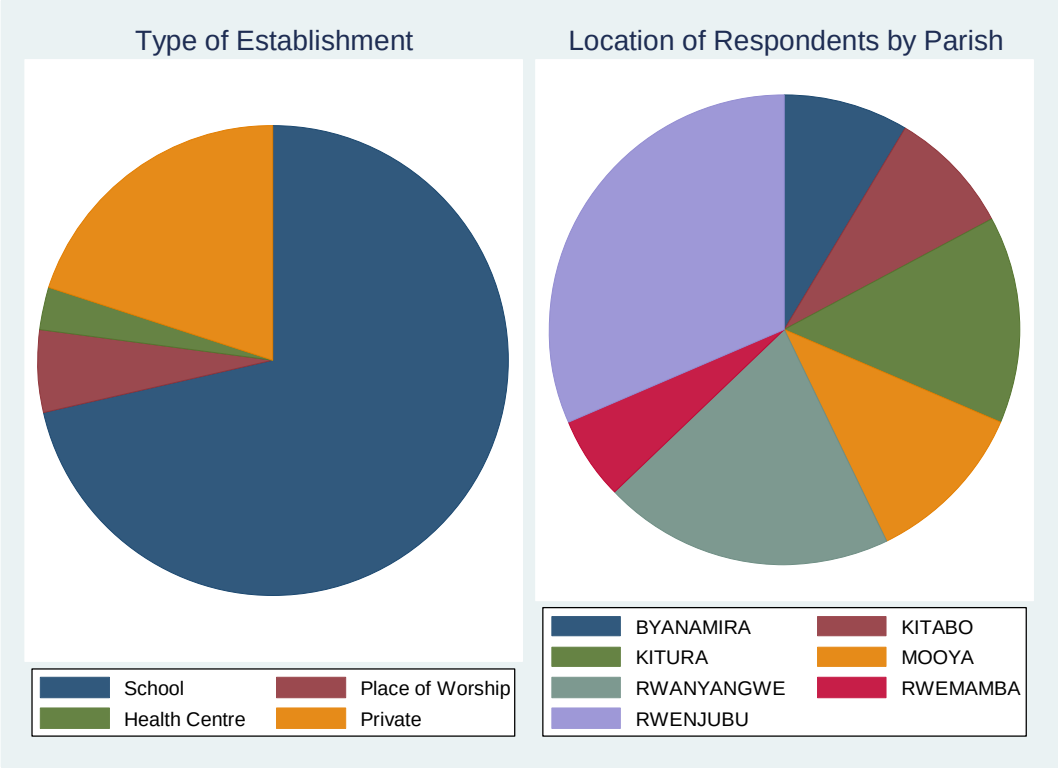


Figure 6. Tank Characteristics

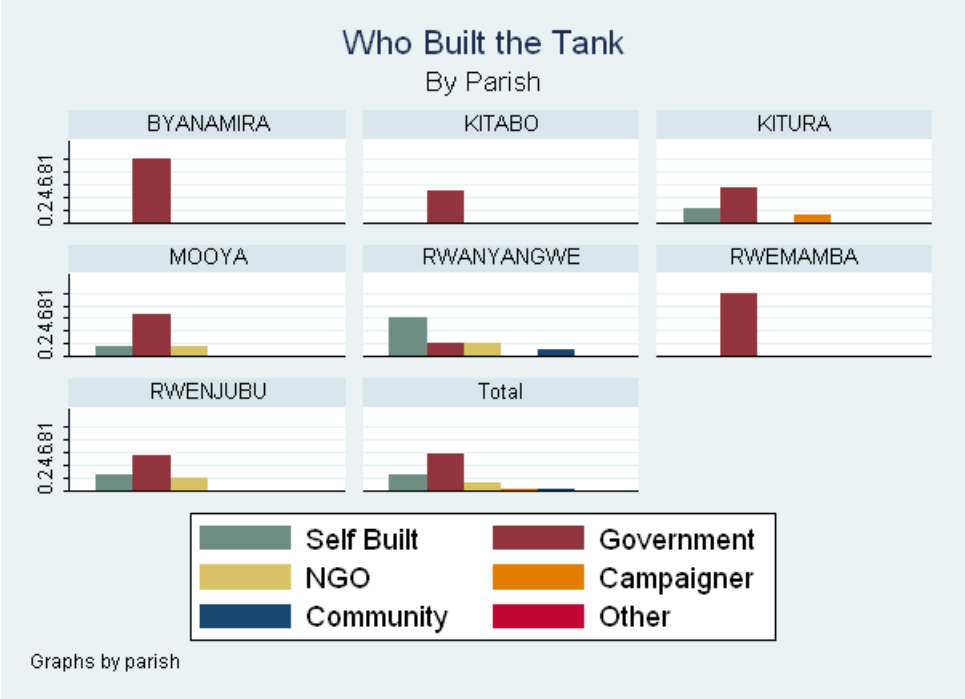
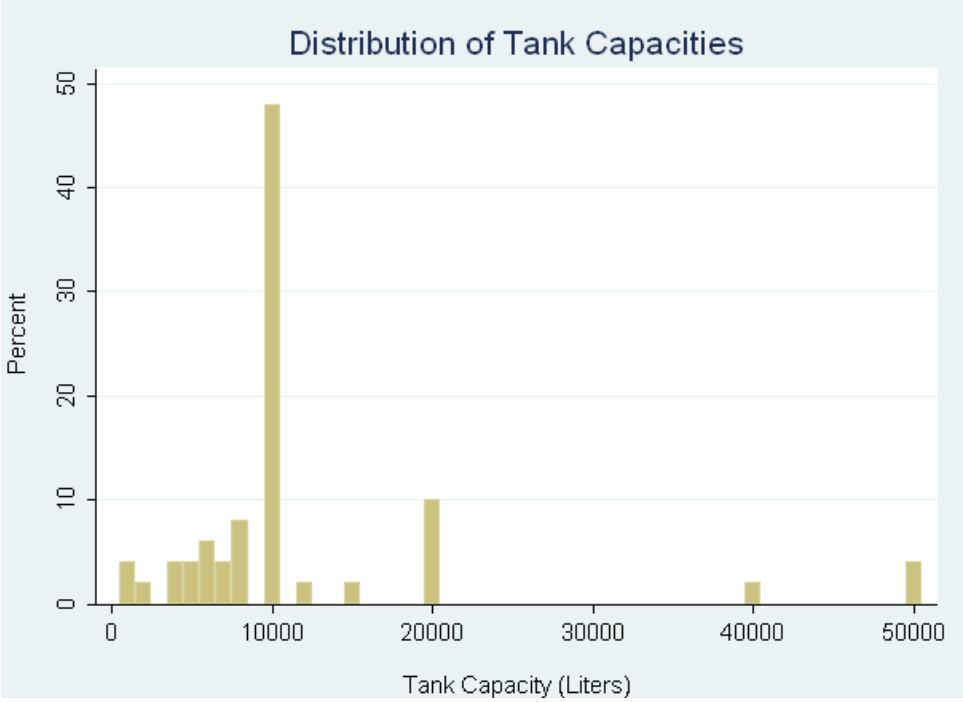


Figure 7. Tank Capacity



The majority of existing tanks are built by the local district government, and then a sizeable percentage of tanks are self-built. About half of the tanks are 10,000 liter tanks; this is the most common by far, followed by capacities smaller than 10,000 liters. 60% of the tanks were above 2.5 years old. At the time of survey, 88% of tanks were functional in some form, while the remainder suffered from damages that rendered them unusable.

Table 4. Tank Holder Maintenance

Variable	Mean Value	Standard Deviation	Observations
Knows how to maintain the tank	0.92	0.28	37
Number of ways known to maintain the tank	2.24	1.38	37
Frequency of tank cleaning (per year)	2.11	1.2	37
Knows a repair contractor	0.69	0.47	32
Number of repair contractors known	1.35	0.86	37
Tank shared with community	0.84	0.37	37
Disruption experienced, if tank shared	0.46	0.51	35
Days dry a year	66.49	37.84	33

Only 8% of respondents could not name a way to maintain the tank, and the average number of ways named was 2.2. However, most of the mentioned ways were basic tasks, such as clearing vegetation around the tank. More advanced methods such as keeping water in the tank during the dry season to prevent cracking was only mentioned by 1 respondent. Furthermore, 31% of respondents could not name a specific contractor they could contact in case of repairs, which is a very troubling finding.

Tanks are dry for about 2 months on average, and 77% of the tanks are dry for more than a month out of a year. 50% of all tank holders have had disputes over water with the community, indicating a level of social conflict experienced due to water shortages. While 84% of tank holders report that they have previously shared their tank with the community, almost half out of this number report that they have experienced disruption to their work as a result. This is a problem since it discourages institutions from sharing their water with the community.

6.2. Household Survey Summary Statistics

The average household size in the sample is about 8 persons, and mean breadwinner income is 5777 Ugandan Shillings (UGX) per day. At time of study, the exchange rate was 1 USD = 2255 UGX, with purchasing power parity (PPP) projected to be about 1 USD = 835 UGX (IMF WEO 2010). Thus, households were earning an equivalent of 6.9 USD per day. Note that the median income is 2000 UGX (2.39 USD). The mean income is much higher than the median income, reflecting skewness in income levels.

60% of households used a RWH tank of some sort, while 42% used IRWH tanks. Households used 135 20-liter jerry cans of water (713 gallons) per month on average, and spent 1.2 hours per day collecting water from their non-tank water source. Note that respondents spent a similar amount of time from a non-tank source as compared a tank. While most tanks do provide time and distance savings, some respondents are willing to travel longer distances to obtain clean water from a tank rather than a closer but lower quality source. Thus, change in water quality rather than time savings is the most likely driver.

Table 5. Household Characteristics

Variable	Mean Value	Standard Deviation	Observations
Household Size	7.55	4.80	116
Uses a Rainwater Tank	0.60	0.49	116
Uses an IRWH Tank	0.42	0.50	113
Considered Constructing a Tank	0.69	0.46	113
Daily Breadwinner Income (in UGX)	5776.77	14267.62	115
Monthly Household Water Consumption (in 20-liter jerrycans)	135.05	126.43	116
Time spent during water collection from non-tank source (hours)	1.20	0.88	99
Time spent during water collection from tank (hours)	0.93	1.59	73
Self-ranked water quality from old source (10 is worst, 1 is best)	7.33	2.54	98
Self-ranked water quality from tank	2.22	1.70	73

Figure 8. Willingness to Pay for Yearly Tank Maintenance

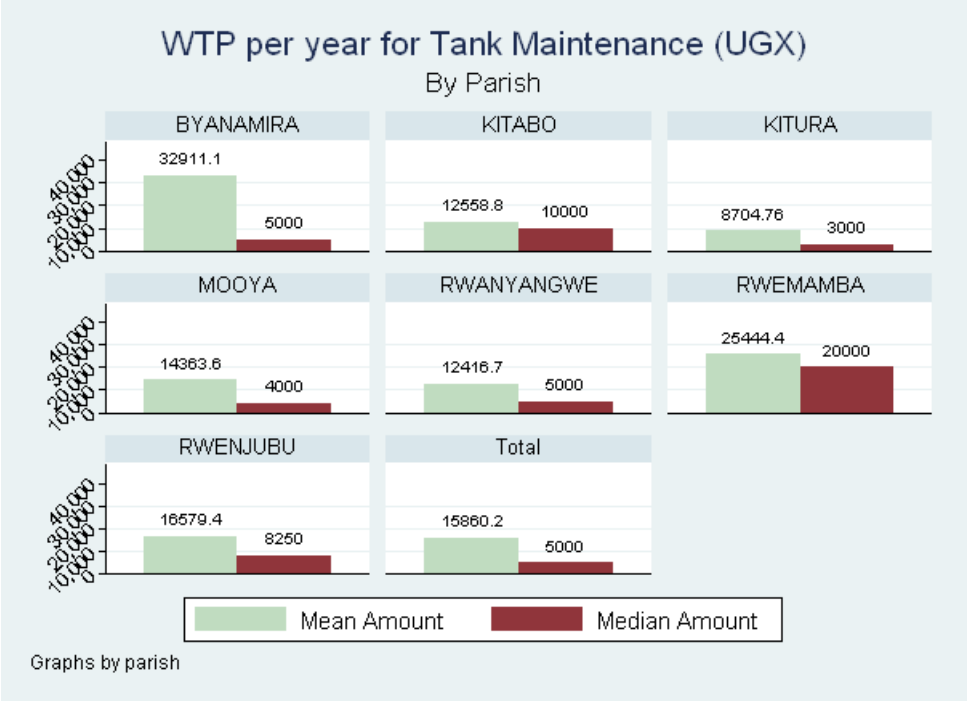
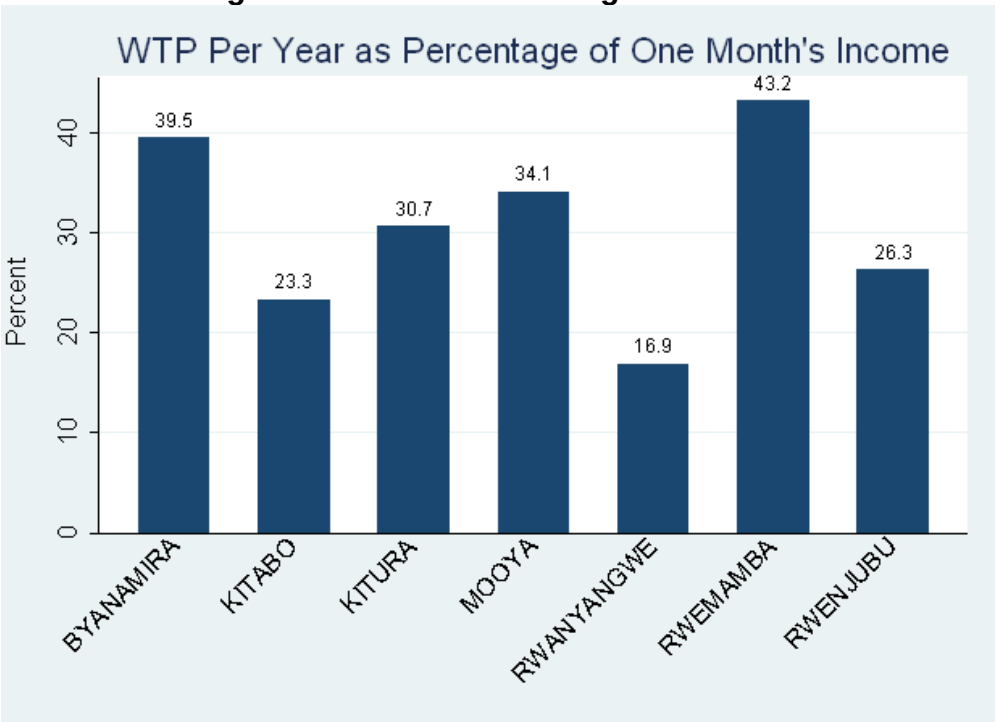


Figure 9. WTP as Percentage of Income



Figures 4 and 5 show the respondents' willingness to pay for yearly tank maintenance, first as the raw amount, then as a percentage of a month of their income, where a month's income is calculated by multiplying the breadwinner's daily income by 30. The numbers shown in Figure 5 seem to be relatively high; as we can see from the graph below, some respondents demonstrate abnormally high willingness to pay a large sum of money. Respondents in Rwemamba parish were willing to pay 43% on average. In the data set, there were individuals who were willing to pay more than 300% (willing to pay 3 months' worth of income for tank maintenance). This may reflect the respondent's inability to make proportional estimation between their income and their WTP, as the surveyors pointed out. On the other hand, many respondents indicated the importance of clean water to them; therefore, the abnormally high percentages should not be discounted as well. Another thing to take note of is that breadwinner income only reflected income flow, and not stock of assets such as agricultural livestock.

Again, the disparity between the mean and median amounts reflects the amount of skewness between the willingness to pay of respondents. Since the data reflects that a small handful of individuals earn disproportionately more than the other individuals, some going up to 50 or 100 times more, we shall take the median value as the more accurate figure.

The key figure to take note of is the overall median WTP for the maintenance of the tank: 5000 shillings. This seems to be a sound figure, since it is roughly 2.5 days of the median daily income in Kashongi, which stands at 2000 UGX. Yet, with this figure, 30 families that rely on an IRWH tank would be able to raise 150,000 shillings per year, for example. This seems to adequately meet the recommended guideline of a yearly maintenance, cleaning and repair fee of 7% of the initial cost of building the tank(Thomas and Martinson 2007, 1-160), which stands at about 2.41 million UGX, according to the MMHF project manager. This translates to 168700 UGX (USD 202) per year in maintenance costs.

6.3. Least-Squares Regression

6.3.1. Willingness to Pay (WTP) Analysis

Table 6. WTP for Yearly Maintenance of Tank (Current RWH Tank Users)

	(1) WTP	(2) WTP	(3) WTP	(4) WTP
Log (Income)	5402.9**	5261.1*	5416.4*	5638.1**
	(2032.5)	(2287.4)	(2260.3)	(2261.9)
No. of Household Members	696.0	490.7	507.7	480.1
	(690.8)	(613.4)	(550.6)	(795.4)
Δ Water quality	154.9	430.4	300.6	350.8
	(932.3)	(1030.5)	(1334.3)	(985.3)
(Δ Water quality)^2	-34.28	-51.54	-34.16	-37.48
	(107.5)	(105.6)	(119.9)	(87.77)
Decrease in time spent	6641.0***	6115.3**	6374.1**	6396.3***
	(1492.9)	(1674.1)	(2209.6)	(1581.6)
Institutional effectiveness	-1307.1	104.1	1516.2	
	(4219.5)	(3683.1)	(2944.3)	
Crime Index		5087.5	6753.0	6203.3
		(8991.9)	(9426.5)	(9606.8)
Other benefits experienced		-7147.2	-7147.3	-7052.6
		(4623.1)	(4646.9)	(4790.3)
Borehole			2344.9	-337.4
			(5910.7)	(3533.0)
Surface water			2701.7	1859.6
			(5749.9)	(4644.8)
Protected well			10103.9	9084.4
			(6922.3)	(6985.8)
WUA Effectiveness Index				-96.39
				(1328.1)
Village Institutional Capital Index				-943.3
				(2246.0)
Constant	-33614.3**	-31483.7**	-36891.7*	-36898.5**
	(11155.1)	(12787.2)	(15612.2)	(13788.4)
Mean WTP: 15477 UGX		*Median WTP: 6000 UGX*		
N	66	66	66	65
R^2	0.251	0.272	0.288	0.307

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: WTP Explanatory Variables (Only for Current RWH Users)

Variable	Description	Mean	S.D.
Log(Income)	Logarithm of the family's breadwinner daily income in UGX, assuming a day has 8 working hours.	7.88	1.27
No. of household members	Number of members in the household	7.78	4.01
Δ Water quality	Increase in self-ranked water quality when using tank water, compared to their original water source	5.13	3.12
(Δ Water quality)^2	Δ Water quality, raised to the power of 2	35.97	22.64
Decrease in time spent	Change in daily time spent when using tank instead of old water source. Units in hours.	0.45	1.20
Institutional effectiveness	Indicator variable for whether problems with the respondent's main water source were solved by relevant community institutions.	0.57	0.50
WUA effectiveness index	First principal component from Factor Analysis (FA). Index variable for perceived overall institutional effectiveness of water-source committees	0	0.95
Village Institutional Capital index	Second principal component from FA. Index variable for perceived institutional capital within the village	0	0.96
Crime index	Index of how much respondents expect crime to be reduced. Includes robbery and rape incidents.	0.17	0.34
Increase in other benefits experienced	Other Benefits of using the tank (e.g. drowning and other accidents)	0.23	0.43
Borehole	Use boreholes as alternate water source. Included 1 observation for springs, since they were the most similar in nature.	0.12	0.32
Surface water	Use surface water (e.g. stream or dam) as alternate water source.	0.41	0.49
Protected well	Use protected wells as alternate water source.	0.13	0.34
Unprotected well	Use unprotected wells as alternate water source. (Note: this was the omitted category)	0.32	0.47

Note: one outlier with anomalously large values for distance travelled and time spent was dropped, because the respondent indicated that she regularly went to great lengths to travel 10km away to Ibanda to collect water, and spends roughly 12 hours doing so. This greatly distorts the regression, and thus was not included.

Four regression models were used to compare the effects of different categories of variables. In every model, observations were clustered by parish to adjust for survey design effects. In the first model, only household characteristic variables for income and household size, variables for the impact of the RWH tank were included, as well as an indicator variable for whether water source problems were solved as a measure for the institutional strength of water-user associations (WUAs). The second model added the crime index as a proxy for

social capital, and other benefits experienced from having a tank such as reduction in drowning incidents. The third model included indicator variables for other water sources available. The fourth model replaced WUA strength with the two indices for institutional strength that were created from PCA. The coefficients for these indices were statistically insignificant. In all four models, breadwinner income, increase in water quality experienced and reduction in time spent collecting water were statistically significant and strongly correlated with WTP. We shall discuss results in the fourth model.

Income is very statistically significant, and is very strongly correlated with willingness to pay. The coefficient of log (income) means that for every 1% increase in income, the respondent is willing to pay an extra 56 UGX (6.7 US cents in PPP equivalent) for tank maintenance. The median income is 2000 UGX (USD 2.40) per day. The variable for number of household members serves as a proxy for the number of children in the household, and also controls for the amount of water the household uses. As the burden of collecting water for the family often lies on the shoulders of the children, households with more children may be less willing to pay for tank water. However, the more water a household uses, the more willing it is to pay for tank water as well. As a result of these two competing effects, we see no significant effect of household size on WTP. The size of the coefficient is large and positive though, indicating that it is likely that the former effect dominates the latter, and WTP increases by 480 UGX (60 US cents) for each extra household member.

An increase in water quality from the tank as compared to other water sources has a positive but statistically insignificant correlation to the WTP. For every unit increase in self-ranked water quality, respondents are willing to pay about 350 UGX (40 US cents) extra. There is a slight negative coefficient on (Δ Water Quality)^2, which is to be expected since there will be decreasing returns. Respondents are willing to pay more than 6396 UGX (USD 7.66) for each hour they save on collecting water. This is the largest statistically significant impact on WTP.

The effectiveness of the village's institutions in solving water source problems has an ambiguous impact. In the third model, the coefficient is rather high at 1516 UGX (USD 1.82), which is a 25% increase from the median WTP, but the level of significance is low. In the fourth

model, where the principal components used as indices for water-source committee effectiveness and village institutional capital respectively, the coefficients for both measures are negative and statistically insignificant. This is possibly due to the small number of observations, but I will explore a hypothesis of competing correlations in the next section. When village-level institutions are effective, there is strong institutional trust. Community members would be more willing to trust village leadership with their money, knowing that it would be used well. This is evidenced in the focus group discussions, where community members were concerned about corruption. However, when alternative water source issues are quickly resolved, there is also a much lower incentive for community members to pay for the maintenance such as a RWH tank since they can continue using other sources with little problem.

I use a crime index as a proxy for social capital, a variable that Polyzou et al. (2010) found significant in WTP for water. There is a large and positive coefficient on the crime index at 6203 UGX (USD 7.43), but it has a low level of significance for the crime index on WTP. Puzzlingly, the variable representing other benefits experienced from using the tank has a negative coefficient. Many responses fell under the category of drowning incidents, such as when collecting water from a surface source like a lake or dam. Hence, we should expect respondents to be more willing to pay for tank maintenance if they thought that accidents such as drowning were serious threats. More research is needed to investigate this discrepancy, although it is not as critical due to the lack of statistical significance.

Accounting for the presence of other water sources produced interesting results for the coefficients of indicator variables, even though the correlations were not statistically significant. Unprotected wells were the omitted category, thus a coefficients for another other water source indicator variable would show the difference in WTP between a respondent who used that source versus an identical one who used unprotected wells. Table 5 shows that boreholes and springs were seen to be the most desirable source of water, while protected wells and surface water sources such as dams were the least desirable (This in itself is a surprising finding, as we would expect protected wells to be of higher quality than unprotected wells. However, a possible explanation for this is gathered from the evidence in the next section.) Thus, we would

expect WTP to be highest for protected well and surface water users, since they would experience a larger increase in water quality. The results matched up relatively well, with WTP being lowest for boreholes, followed by unprotected wells. Protected wells and surface sources took up the last spots. In the third model, however, respondents are more willing to pay for boreholes than for unprotected wells. This unusual result might be due to the small sample size.

Table 8: Self-ranked water quality, by source type (All Respondents)

Other Water-source Type	Mean Ranking	Number of Observations
All sources	7.3	95
Boreholes and springs	5.3	10
Surface water (Rivers, streams, dams, ponds)	8.4	37
Protected wells	7.3	10
Unprotected wells	6.9	38

These models only include current IRWH tank users, and are not representative of the entire sample. Thus, I ran another group of models that included all respondents in the survey. Some of the variables had to be modified, since they required the respondents to be currently using a tank. Also, WTP to pay for a tank would only be hypothetical for respondents who did not have a tank. Instead, I used WTP for clean tank water as the new dependent variable. This was not a problem for the respondents, since they regularly bought clean water from private water vendors. Also, I replaced variables for change in water quality and change in time spent to simply water quality and time spent collecting water from current source. The results that I obtained were similar to the WTP for tank maintenance regression. Please refer to Table 17 in the Technical Appendix.

6.3.2. Analyzing Institutional Strength.

We see that institutional strength has a positive, but statistically insignificant correlation with WTP for tank maintenance. This may be due to the small number of observations, but I will investigate a possible mechanism at play. I make the following hypotheses :

1) Institutional strength has two competing correlations on WTP
    a. When institutions are strong and trusted, respondents are more likely to be willing to pay.
    b. When institutions are effective, alternative water sources are better maintained. Thus, respondents are likely to be less willing to pay.
2) Because of these opposing forces, we will not be able to speculate the direction of how institutional strength will be correlated with WTP. Whichever force dominates will have to be determined empirically.

The quality of water from a water source will have 2 components: one that is natural, and another that is associated with institutional strength. This leads to my next hypothesis:

3) If $\frac{\partial(Other\ Source\ quality)}{\partial(Institutional\ Strength)} > 0$, then the second competing correlation is present.

I test for this hypothesis by running a correlation between institutional strength and other-source quality. We find that the correlation between the two variables is mildly positive. However, we obtain much more interesting results when we break down the correlation by the type of water source.

Table 9: Correlation between Institutional Strength and Other-Source Quality, Broken down by Source Type (All Respondents)

Other Water-source Type	Correlation with Institutional Strength Index	Number of Observations
All sources	0.1440	95
Boreholes	0.4137	10
Surface water (Rivers, streams, dams, ponds)	0.06673	37
Protected wells	-0.596	10
Unprotected wells	0.328	38

What catches the eye first is that there are large, positive correlations between institutional strength and water quality from boreholes and unprotected wells. However, the coefficient for surface sources is extremely small. This could possibly be the result of the fact that larger surface water sources such as dams and irrigation channels would not be managed by village-level institutions, but rather by sub-county level government institutions.

Another interesting result is the large difference between unprotected wells and protected wells, since protected wells have a strong negative correlation with institutional strength. This seems counter-intuitive on the outset, but this can be explained by the qualitative data. From the focus groups, we find that most protected wells are fenced through investments by the villagers themselves, while the rest are privately owned. It would make sense that the weaker the institutions are in this circumstance, the more incentive there is for villagers to invest in protecting their own wells.

These findings, although just supported by assumptions, are also supported by qualitative data, and are consistent with hypothesis (3). Accordingly, this seems like a reason why the coefficient for institutional strength in the WTP regression is statistically insignificant, as stated in hypotheses (1) and (2). Since the coefficients for all measures of institutional strength are positive, we can conclude that the first positive competing effect dominated the second negative one.

6.3.3. Tank Functionality Analysis

Table 10: Tank Functionality, (All Respondents)

	(1) Frequency of tank breakage (per year)	(2) Frequency of tank breakage (per year)	(3) Number of days dry (per year)	(4) Number of days dry (per year)
Public school	0.0136	-0.0328	54.48**	52.17**
	(0.0852)	(0.0748)	(16.08)	(16.31)
Place of worship	0.171	0.0282	37.52	32.50
	(0.380)	(0.308)	(33.98)	(39.82)
Government building	0.0223	-0.00218	45.74**	44.90*
	(0.154)	(0.154)	(17.78)	(18.60)
Private school	-0.250	-0.368*	7.071	3.022
	(0.134)	(0.157)	(24.97)	(24.86)
Ferro-cement tank	0.463**	0.499***	-40.23	-37.58
	(0.142)	(0.131)	(22.77)	(22.98)
Plastic tank	0.867**	0.877***	-20.44	-18.60
	(0.239)	(0.204)	(20.41)	(20.77)
Committee Involvement Index	-0.0524	-0.0624	9.280	8.375
	(0.120)	(0.137)	(9.446)	(9.375)
Night watchman Index	-0.174*	-0.144	18.64*	19.70**
	(0.0865)	(0.113)	(7.956)	(7.602)
Unlimited water distribution	-0.641*	-0.722**	38.44	35.18
	(0.267)	(0.255)	(22.72)	(22.08)
Variable water distribution	-0.216	-0.226	-9.454	-10.42
	(0.194)	(0.149)	(9.810)	(8.987)
Parish institutional strength		-0.919*		-30.11
		(0.407)		(34.57)
Constant	0.0992	0.599**	57.08***	72.75***
	(0.0540)	(0.196)	(10.79)	(15.30)
Mean Frequency	0.42			
Mean Days Dry	61			
N	47	47	51	51
R^2	0.330	0.361	0.604	0.612

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Tank Functionality Dependent Variables

Variable	Description	Mean	S.D.	Obs.
Frequency of tank breakage (per year)	Number of times a tank has broken down before, divided by the age of the tank in years.	0.42	0.63	48
Number of days dry (per year)	The number of days a tank ran dry per year.	67.44	40.79	48

Table 12: Tank Functionality Explanatory Variables

Variable	Description	Mean	S.D.	Obs.
Public school	Establishment is a public school	0.55	0.50	29
Private school	Establishment is a private school	0.13	0.34	7
Place of worship	Establishment is a place of worship (all in sample are churches)	0.06	0.23	3
Government building	Establishment is a health center or government office	0.08	0.27	4
Private establishment	Establishment is a commercial shop, or belongs to a private neighborhood	0.19	0.39	10
Ferro-cement tank	Ferro-cement tank	0.54	0.50	28
Plastic tank	Plastic tank	0.38	0.49	20
Other tank	Other tanks. Includes masonry and underground tanks	0.08	0.27	4
Committee Involvement index	First principal factor for index of institutional strength at the tank committee level. Primarily indicates whether committee collects funds and mobilizes the community as part of duty.	0	0.88	53
Night Watchman index	Second principal factor for index of institutional strength at the tank committee level. Primarily indicates whether night watchman is part of the tank committee, and the presence of related duties	0	0.88	53
Fixed Distribution	A fixed amount of water is distributed e.g. 20 liters per person. This is the omitted category.	0.23	0.43	52
Unlimited distribution	There is no limit placed on how much can be collected from the tank	0.15	0.36	52
Variable distribution	The amount of water that can be collected varies, either with the season or with the amount left in the tank.	0.62	0.49	52
Parish institutional strength	Index of institutional strength at the parish level. An average of perceived WUA effectiveness within each parish	0.477	0.144	7

Note that the dataset was modified such that the unit of observation was a tank rather than an establishment. In other words, establishments with multiple tanks will have multiple data points, each with individual tank data. I run four models for tank functionality, with two models each for the two dependent variables, frequency of tank breakage and number of days dry per year. In

the second specification for each dependent variable, I added a variable for parish-level institutional strength. We shall explore findings from these specifications.

We see that building type largely has a statistically significant correlation with number of days the tank is dry, but is mostly not statistically significant for the frequency of tank breakage in a year. The omitted category here is privately-owned buildings (commercial shops and tank-sharing houses in a private neighborhood). Tanks at private schools have the lowest frequency of breakage. They break 0.37 times less per year than private buildings do. More significantly, they break 0.34 times less per year than public schools do. In terms of the number of days dry per year, private schools and private establishments top the chart. Although this coefficient is not statistically significant, it shows that they are able to provide water from their tanks for almost two months longer than public schools can.

Tank type is statistically significant for breakage frequency, but not for days dry. The omitted category here is “other”, which includes masonry and underground tanks. Both ferro-cement tanks and plastic tanks are common (54% versus 38%). Ferro-cement tanks are 0.38 times less likely to break down in a year than plastic tanks are. Ferro-cement tanks are a recent technology, specially developed for use in the developing world. The body of the tank consists of a steel-wire frame encased in cement, and drastically reduces the amount of material needed. Literature suggests that they are more durable than plastic tanks, a statement that has some empirical support here. Masonry and underground tanks seem to be the most durable. However, they are significantly more expensive than either ferro-cement or plastic tanks, making them less feasible as alternatives.

The tank committee involvement index is not significant in either model. However, the night watchman index is statistically significant, and has a large coefficient. Since both indices have the same sign on their coefficients, and the latter has a larger coefficient, I shall discuss the night watchman index in greater detail. The night watchman index is normalized to a mean value of 0. The largest score obtained was 2.32, while the lowest score was -0.752. Many of the tank committees obtained small negative scores, while there were a small number of large, positive scores, reflecting skewness in the data.

For an increase in 1 unit on the night watchman index, the frequency of tank breakage decreases by 0.144 times per year. This is almost a 35% decrease in breakage frequency. However, higher tank committee strength also correlates with more days dry per year, which was an unexpected finding. An increase in the night watchman index by 1 unit increases days dry by almost 3 weeks. On further consideration, a plausible explanation is that the faster the tank runs dry, the more active the tank committee would be in undertaking corrective action. Another possible explanation is that the night watchman expropriates water from the tank for personal use or for sale. This can be easily done since nobody else would be around the tank. If this finding was true, there would be much cause for concern. It would be meaningful to conduct a more substantive investigation into this.

In terms of water distribution methods, three categories were observed: no limit on water use, fixed distribution (e.g. 1 jerry can per household per day) and variable distribution (varies by dry/wet season or by the amount left in the tank). These categories represent levels of water demand management. Fixed distribution is the omitted category here. The variable for unlimited distribution is statistically significant in all cases, but not the one for variable distribution.

We see that a lack of water demand management is related to an increase in days dry by about a month and a half more per year than if a moderate amount of water demand management was employed in distribution. This is almost double the length of time the tank is not functioning. Variable demand management is correlated with the least days dry. However, having no limit on water distribution also has an association of reducing tank breakage frequency by 170%. This is most likely due to the fact that the amount of time the tank is being used is reduced by half. Thus, exposure to wear and tear through usage is reduced.
Having said that, we need to keep in mind that the type of water demand management is also reflected in whether the tank is shared with the community, or not. For example, certain government buildings like the sub-county office only allow civil servants to use the water. Furthermore, certain schools do not share their water with the surrounding community. Since

these establishments do not open their tanks for usage to the general community, there is no need for a limit on water usage, and therefore both breakage and days dry would be reduced.

The variable for parish-level institutional strength captures information on the effectiveness of WUAs. Also, it serves as a proxy for institutional arrangements outside of the establishment, such as the presence of tank maintenance networks in the area. It has a mean value of 0.477, a maximum score of 0.778 and a minimum score of 0.273. This variable also is likely to have some effect on tank committee strength as well. Interestingly, it has a correlation of 0.175 with the night watchman index, and -0.216 with the tank committee involvement index.

Parish institutional strength has a statistically significant correlation with frequency of breakage, but not for number of days dry. It is associated with a reduction in breakage frequency by more than 200%, and is the strongest predictor. It also correlated with a decrease in number of days dry by a month every year.

6.3.4. Implications

We see that the amount of time saved collecting water is the biggest driver of a household's willingness to support the community tank. Thus, agencies should consider build tanks as close as possible to the population, amidst other competing concerns.

The significance of the Night Watchman Index presents an interesting and intuitive implication. Establishments should have a caretaker on the ground that works intimately with the tank, and he/she should directly report to the management committee. Also, his/her actions should be closely monitored. Further research into rural high-investment, shared water infrastructure systems should take measures similar to the Night Watchman Index into account.

Meinzen-Dick (2010) states that collective action does not often occur spontaneously, even in conditions of scarcity. Thus, external agencies should serve as catalysts to stimulate the growth of collective action organizations. Since local institutions at the tank committee-, WUA- and parish-levels were found to be significant predictors of IRWH tank sustainability, agencies need to strategically tailor suitable policy at multiple levels.

7. Recommendations

Several recommendations can be made from the focus group and interview results. Firstly, the committees formed to manage individual tanks are crucial. Elections should be held, and re-elections should be held every few years so that ineffective and members of will be dropped (Rev. Byomuhangi, Interviews with Key Informants). The leader of the establishment (e.g. school headmaster, church pastor) should be on the tank committee. Also, since existing water-user committees have indicated in focus groups that they are unsure of their duties, it is crucial for tank committees to be trained and educated on various aspects of tank management.

Currently, existing water-user committees have the backing of Local Councils (LC1s), and the same powers should be given to tank committees, so as to ensure fairness in payment. Furthermore, because of concerns reflected in the focus groups over corruption and ineffectiveness, Community Volunteer Counselors (CVCs) should be employed and trained to be supervisors of the IRWH tank system, providing a measure of accountability from the tank committees.

Agencies like MMHF can take the step of identifying masons that have general training from Kashongi sub-county and surrounding sub-counties, and send them to specialized RWH training programs, such as the ones organized by the Diocese of Kigezi Water and Sanitation Program. This will result in increased availability of repair services to the tank holders, and thus decrease down time. Also, with more contractors, prices charged for repair will decrease, making it cheaper for tank committees to repair the tank.

Agencies also need to engage in upfront education of the community through exposure to the technology behind the tanks. There can be an exhibition of the tanks at each village after the tank construction is complete. This helps them understand how the tanks work, and where the cost of parts of the tanks like the taps, gutter, and first flush system come from. Furthermore, there needs to be communication with the community to hear about their needs and concerns

and to clear up any misunderstandings. This will do much to greatly reduce hostility and resentment against any perceived unfairness.

Agencies need to sign a contract with all parties involved with the tank, such as the establishments who receive the tank, tank committee members, and the CVCs. This is crucial because it ensures that they do not renege on their promises, and if they do, they can be taken to account for the benefit of the whole community. This would ensure that the NGO is seen as upholding its promised level of service to the community, an essential component in maintaining the trust of the community.

Lastly, agencies should also identify promising villages with characteristics of strong institutions to invest in, in order to make the most impact out of the limited resources that they have. Also, since institutions are important to collective action and IRWH tank sustainability, agencies should seek to foster suitable institutional arrangements within villages with weak collective action organizations.

8. Conclusion

Communities in Kashongi are indeed able and willing to be responsible for the financial sustainability of IRWH tank systems. However, the actual sustainability of the IRWH tank system is also contingent on ability of the community to use the funds well. Agencies with limited funds should not disburse them for the yearly maintenance of the tanks, but rather focus their efforts on improving the quality of local management and maintenance. A caution is that poorer villages in parishes might not be able to upkeep the tank at a desired level of maintenance, and need strategic support.

The empirical results from this study largely support the hypothesis that institutions are significant predictors of IRWH tank sustainability. Tank functionality in terms of breakage frequency and reliability are correlated with institutional strength, both at the tank committee- and at the parish-level. At a cursory glance, the strength of local institutions only has a positive but statistically insignificant effect on WTP. However, a more careful look at the data suggests that institutional strength is possibly associated with tank sustainability through competing effects of institutional trust and institutional effectiveness, as suggested by the literature. Lastly, sensible water distribution methods are correlated with higher tank functionality. However, more needs to done to uncover the underlying mechanisms.

Sustainable community-based rural water supply solutions like IRWH tanks systems are crucial in combating water scarcity and poverty. By improving the ways in which we understand how institutions and the effectiveness of these solutions are related, we have a better shot at effective lasting change in the lives of those who struggle with access to water. Further research would be able to build on the findings of this study in several ways. Increasing the number of household surveyed would improve the robustness of the results. Several steps should be taken to reduce sample selection bias, such as the inclusion of possible respondents who lived in remote areas and were not surveyed. Also, a post-intervention study should be conducted. This would allow us to track existing tanks over different periods, and thus introduce fixed effects analysis. We would also obtain data

regarding the performance of WUAs and tank committees in fund collection, allowing us to analyze how institutional strength affects the elasticity of funds collected on tank functionality.

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Appendix A- Focus Group Summary Report

8.1.1. Key points from Community Members

a. On Water-user Committees:

Current water-user committees (WUCs) are receiving mixed reviews; some of them are effective, but some are not active. The community wants WUCs to have representatives from each village, so as to ensure that their rights are taken care of, and to have someone nearby to contact in case of problems. Corruption is a very real threat, and the community is extremely concerned about the possibility of the elected WUCs being corrupt, especially when large sums of money are collected to fund maintenance and repair. The community is also willing for the tanks to be taken over by the local schools should the community fail in their management of the tanks.

b. On Tank Usage:

The community members are worried that tanks built in schools will only be readily available to families living around it; other families will still have to travel long distances for the water. They prefer students not to use water from the public tank, but will still allow them to fetch since the children are theirs. Also, the community is ready to adopt strict demand management practices such as using the water only in the dry season in order to avoid water scarcity. In the rainy season, most households already have access to rainwater from their own rooftops, so they should not be getting more water from the tank. Community members would pay for maintenance of the tank, but not per unit of water they obtain from the tank. There must be equal distribution of water; the rich cannot get more than the poor.

8.1.2. Key Points from WUC Members

a. On the Structure of the Committees:

The committees would have the backing of local government, such as the Local Council 1 Chairperson (LC1) at the village level, and the LC5 chairperson at the district level. The LC1 chairpersons should and would have the power to penalize those who refuse to pay up for maintenance of the tanks, such as giving them fines. This system is already being carried out in some villages for collection of fees for boreholes and other water sources.

b. On the Duties of the Committees:

WUC members feel that they are not aware of how to carry out their duties. They feel like they need to be sensitized and trained on how to use and maintain their tanks, so that they can pass this information on to others as well. As a result, WUCs face many challenges in doing their work. Committee members made the point that the group that built the tank should step in to sensitize the community on how to use the tank water, especially for stricter rules such as a limit of water per day, even if the rules are decided upon by

the committee. This is because the people will not believe people on the water committees, and they will require outsiders to step in.

c. On the Usage of the Tank:

Committee members feel that there should be a timetable for the fetching of water so that the collection would be orderly. Also, there should be a calculation to estimate the amount of water each household should collect. They feel that water from the tank should only be used for drinking during the dry season.

Appendix B- Key Informant Interview Summary Report

8.1.3. Cost Sharing with the Community

Communities that are more invested in their tanks through the provision or funds, labor or materials are much more likely to take responsibility of the tanks, thus ensuring its sustainability. According to ACTS, IRWH projects that have little to no cost-sharing often fail in the long-run due to a lack of concern and relegation of responsibility by the community. It is possible for the community to provide its own funds for maintenance, but the problem is convincing them that it is worth the money in terms of the payback it will give them. There is a need for strong community institutions to follow up through enforcement, since volunteer payment is difficult to enact in practice. Also, the more self-interest is involved, the more likely the community members are in cooperating.

8.1.4. Adaptation of System to Local Geography and Need

The technology and the approaches used in implementation must be adapted to local geography and varying community situations. Also, KDWSP advocated a hands-off approach, and let committees decide what is best for their own communities. The KDWSP ranks communities according to need, and maximizes resources by pulling out of communities that are uncooperative.

8.1.5. Special Provisions

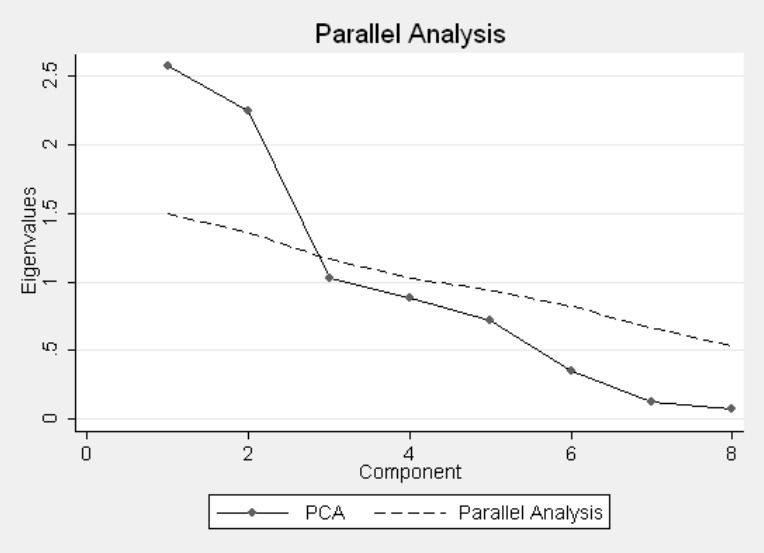
According to Reverend Byomuhangi, there should be extra provision made for marginalized groups such as HIV/AIDs patients, children, the elderly and widows. This is because they are groups that suffer most from water deprivation, in terms of waterborne disease, difficulty of travel and drudgery from labor. Even during the dry period, they should have water set aside for them.

Appendix C- Technical Appendix

8.1.6. Parallel Analysis

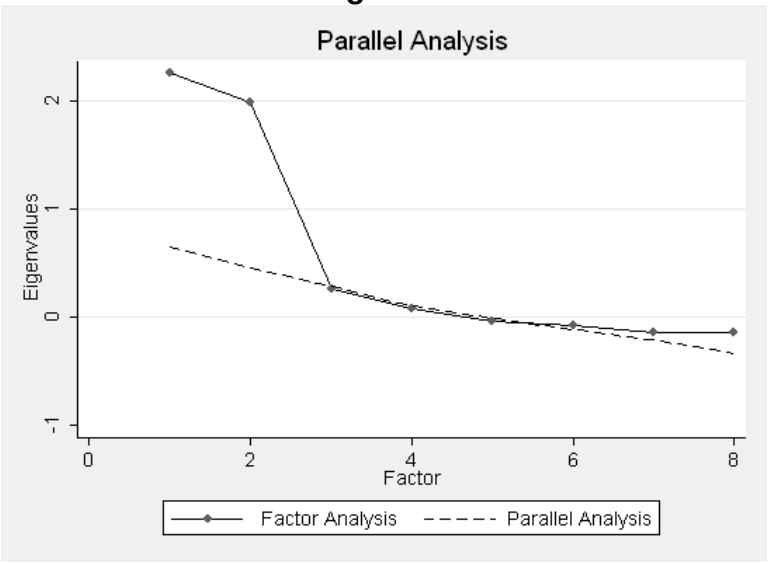
I used parallel analysis to determine how many principal components should be retained from PCA. Using the fapara command generates a random dataset, from which a correlation matrix and its eigenvalues are computed. Ten replications are performed, and the averaged eigenvalues are compared against the eigenvalues from PCA as more components are added. Once the values from parallel analysis are larger than from PCA, we know that the components are mostly random noise. I perform this analysis for the creation of the various village institutional strength indices.

Figure 8.



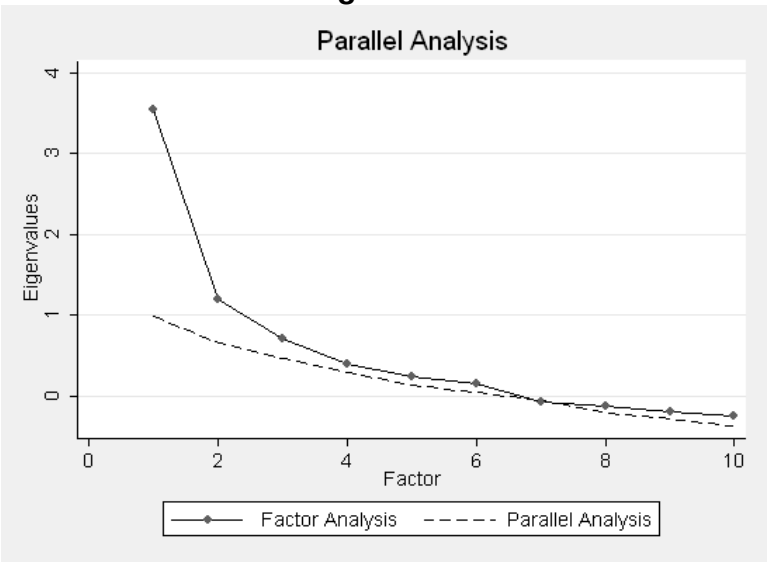
We see that eigenvalues from the parallel analysis are lower than from PCA until they intersect before three components are used. Thus, two components should be included.

Figure 9.



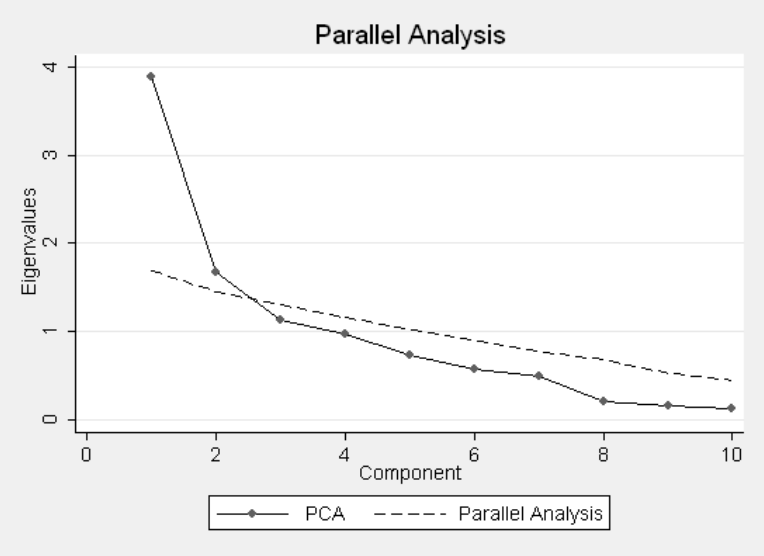
We do comparison for the factors developed from factor analysis. We see that at least two components and up to three can be used. This is because the eigenvalues from parallel analysis and from factor analysis match up close to the point where three factors are added.

Figure 10.



For tank committee strength indices, we see that eigenvalues from the parallel analysis are mostly higher than from FA throughout. However, there is only a significant higher value up two components.

Figure 11.



For tank committee strength indices, we see that eigenvalues from the parallel analysis intersect before three components. Thus, only two should be used.

8.1.7. Weights of variables in each index

Table 13. WTP using un-rotated PCA

Question represented by variable	Factor 1	Factor 2
Have you ever contacted this person or group before?	0.5256	-0.0574
Was the person or group helpful?	0.5721	-0.1371
Was the problem solved?	0.5737	-0.0497
Do you know whether, in the last 12 months, a community meeting has occurred in this village?	0.015	0.6222
During the last 12 months, did you or another member of your household participate in a community meeting?	0.00243	0.607
Do you know whether, in the last 12 months, people in this village have worked together in a cooperative?	0.1572	0.3507
During the last 12 months, did you or another member of your household participate in a cooperative?	0.192	0.2213
Do you know whether, in the last 12 months, people in this village have formed a health fund?	0.0703	0.219

From this table, we see that variables for WUA effectiveness are the most present in factor 1. The perceived approachability of the WUA has a value of 0.526. The perceived helpfulness of the WUA has a value of 0.572, while the ability of WUA to solve reported problems has a value of 0.574. Thus, I name factor 1 the WUA Effectiveness Index

The variables most represented in factor 2 reflect the presence of village community meetings in the last 12 months (0.622), and whether the respondent's household had participated in them (0.607). The presence of a cooperative in the village was also represented (0.35). I name factor 2 the Village Institutional Capital Index.

Table 14. Tank Functionality Regression using rotated FA

Question represented by variable	Factor 1	Factor 2
Do you have a committee that oversees the management of the tank?	-0.1927	0.0041
Who are the committee members? Answer: Night watchman	-0.0642	0.5521
Who are the committee members? Answer: Student/child	0.1008	0.0281
Who are the committee members? Answer: Member of community	-0.0485	-0.0946
What are the duties of the committee? Answer: Collecting funds	0.3278	-0.0293
What are the duties of the committee? Answer: Mobilizing the community	0.6697	-0.1301
What are the duties of the committee? Answer: Other	-0.0553	0.4103
Name the ways which you would maintain a tank (coded into number of ways)	-0.0201	0.04515
How many repair contractors do you know of?	-0.0101	-0.0195
How often is the tank cleaned a year?	0.0009	0.0633

The tank committees were asked questions regarding the duties that they performed. Basic duties involved cleaning and repairing the tank, and simply having meetings. The variables for fund collection (0.327) and mobilization of the community (0.670) represented a higher level of involvement, and were the most significant in factor 1. Thus, I name this factor the Committee Involvement Index.

The variables that had the heaviest weights in factor 2 were indicators for the presence of a night watchman on the tank committee (0.552), and if the tank committee performed duties categorized under “Other” (0.410). Under “Other”, many of such duties included regulation of tank use, security of the tank, procuring materials for repair, and reporting on the status of the tank. These are largely responsibilities of the night watchman, and clearly factor 2 is picking up on this. While the survey question’s intent was to find out if the night watchman was represented on the tank committee, I find that the variable is likely to be picking up on whether there was a night watchman present in the first place. Since both variables have low means of 0.151 and 0.208, it probably means that the majority of establishments do not have a night watchman, and the duties that he/she normally provides.

I label factor 2 as the Night Watchman Index, and take it to represent the presence of a night watchman and his/her associated duties.

8.1.8. Comparison of alternate WTP regressions using only tank users versus all respondents

Table 15.

	(1) WTP for clean tank water (UGX per jerry can)	(2) WTP for clean tank water (UGX per jerry can)	(3) WTP for clean tank water (UGX per jerry can)
Log (Income)	15.62	17.31	15.69
	(8.899)	(9.515)	(10.26)
No. of Household Members	-1.683	-1.263	-0.801
	(3.257)	(3.311)	(2.540)
Δ Water quality	13.26	17.65	8.722
	(17.96)	(29.13)	(25.71)
(Δ Water quality)^2	-1.800	-2.190	-1.496
	(1.656)	(2.441)	(2.225)
Decrease in time spent	48.42**	55.12***	57.28***
	(19.35)	(12.93)	(13.88)
Institutional effectiveness	9.918	28.71	
	(35.18)	(27.96)	
Borehole		62.74**	45.47
		(18.50)	(25.69)
Surface water		26.56	25.89
		(17.10)	(15.54)
Protected well		244.1**	226.2*
		(91.78)	(100.3)
WUA Effectiveness Index			-4.139
			(10.98)
Village Institutional Capital Index			-21.84
			(15.66)
Constant	18.27	-68.76	-18.21
	(86.43)	(138.8)	(133.0)
N	94	94	92
R^2	0.086	0.284	0.294

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

8.1.9. Comparison of alternate regressions between using PCA/FA

a. WTP for yearly tank maintenance regression

Table 16.

	(1) WTP	(2) WTP	(3) WTP	(4) WTP
Log (Income)	5593.5**	6080.4*	5615.3**	5637.8*
	(2233.9)	(2486.1)	(2204.9)	(2314.5)
No. of Household Members	598.5	409.8	567.4	529.3
	(700.4)	(738.6)	(614.9)	(756.9)
Δ Water quality	118.4	249.3	200.4	294.0
	(1170.9)	(1158.5)	(1331.6)	(1041.9)
(Δ Water quality)^2	-8.566	30.69	-18.91	-29.14
	(99.25)	(109.3)	(118.1)	(94.04)
Decrease in time spent	6727.3**	6328.2**	6671.9**	6547.8***
	(2033.5)	(1804.4)	(2113.4)	(1756.9)
Institutional effectiveness	7039.8	7038.0	6766.6	6386.3
	(9603.7)	(9810.3)	(9297.7)	(9841.3)
Crime Index	-5836.8	-5762.2	-6400.8	-6894.3
	(4931.1)	(4451.7)	(4628.7)	(5229.9)
Increase in other benefits experienced	1447.4	4384.9	974.4	458.4
	(4376.8)	(5629.3)	(5588.5)	(4222.3)
Borehole	2818.0	2757.3	2661.7	2309.2
	(5548.0)	(5463.6)	(5722.3)	(4966.3)
Surface water	10160.0	12351.6	10244.7	9829.3
	(6669.8)	(7768.5)	(7077.2)	(6449.1)
Protected well	586.6	-154.3		
	(2095.7)	(2571.1)		
WUA Effectiveness Index		3392.6		
		(2257.7)		
Factor Analysis-Calculated WUA Effectiveness Index			436.3	407.6
			(1685.6)	(1839.7)
Factor Analysis-Calculated Village Institutional Capital Index				-783.3
				(3046.6)
Constant	-38807.3**	-43658.8*	-38431.8*	-37858.7**
	(15532.6)	(18031.2)	(16382.4)	(15004.3)
N	65	65	65	65
R^2	0.291	0.307	0.290	0.291

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

b. Tank Functionality regression

Table 17.

	(1) Frequency of tank breakage (per year)	(2) Frequency of tank breakage (per year)	(3) Frequency of tank breakage (per year)
Public school	-0.0328	-0.0798	-0.118
	(0.0748)	(0.0634)	(0.191)
Place of worship	0.0282	-0.0213	-0.0153
	(0.308)	(0.308)	(0.376)
Government building	-0.00218	-0.106	-0.128
	(0.154)	(0.148)	(0.102)
Private school	-0.368*	-0.507***	-0.526**
	(0.157)	(0.110)	(0.165)
Ferro-cement tank	0.499***	0.447***	0.471***
	(0.131)	(0.0818)	(0.0944)
Plastic tank	0.877***	0.895***	0.913***
	(0.204)	(0.188)	(0.194)
Committee Involvement index	-0.0624	-0.0650	
	(0.137)	(0.146)	
Night watchman index	-0.144		
	(0.113)		
Unlimited water distribution	-0.722**	-0.626**	-0.635***
	(0.255)	(0.179)	(0.163)
Variable water distribution	-0.226	-0.126*	-0.149**
	(0.149)	(0.0634)	(0.0478)
Parish institutional strength	-0.919*	-1.073**	-0.926**
	(0.407)	(0.362)	(0.250)
PCA-calculated Committee Involvement index			0.00623
			(0.199)
PCA-calculated Night watchman index			-0.0595
			(0.115)
Constant	0.599**	0.677**	0.635**
	(0.196)	(0.193)	(0.172)
N	47	47	47
R^2	0.361	0.336	0.336

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix D- Household and Tank Holder Survey Forms

Institutional Rainwater Harvesting Sustainability Survey for Households (July 2010)
Progressive Health Partnership/Duke University and Mayanja Memorial Hospital Foundation

IDENTIFICATION			
Household ID……. Respondent Name_____ Respondent Line Number…… Household Head Name_____		Sub-County_____ Parish_____ Village_____ Cluster ID……. GPS Coordinates – **RECORD UP TO 15 DECIMAL POINTS** *S:* *E:*	
INTERVIEW VISITS			
	1	2	3
DATE: SURVEYOR ID: RESULT:	Month Day Year	Month Day Year	Month Day Year
RECORD DATE AND TIME OF NEXT VISIT REQUESTED BY RESPONDENT.	Month Day Year Hours Minutes	Month Day Year Hours Minutes	

INFORMED CONSENT
The informed consent script has been read and the respondent has agreed to participate in the study.

_____
Surveyor's Signature

RECORD THE START TIME

☐☐ ☐☐
Hours Minutes

RESULT CODES

1 COMPLETED
2 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT TIME OF VISIT
3 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME
4 POSTPONED
5 REFUSED
6 DWELLING VACANT
7 DWELLING DESTROYED
8 DWELLING NOT FOUND
9 OTHER_____
(SPECIFY)

INSTRUCTIONS: AFTER REACHING AN APPROPRIATE HOUSEHOLD, ASK TO SPEAK WITH THE HIGHEST-RANKING MEMBER.

Replaced with: ☐☐☐☐

SECTION A: HOUSEHOLD CHARACTERISTICS

1.	How many people are there in your household? **Abantu abari omukayawe nibangahi ?**	☐☐	
2.	Do you rely on an institutional rainwater harvesting tank for water? **No koresa za tanka za abingi kugira ngu obase kubona amaizi?** Tick YES only if household ever draws water from a public building. TICK NO if the household draws from a neighbour's or private tank. If the tankj is the household's main source, please write "Main Source"	YES……..1 NO……2	
3.	What is water from the tank used for? **Amaizi gomu tanka nogakozesaki?**	DRINKING……...1 BATHING…….2 HANDWASHING…….3 COOKING……4 ANIMALS (NP)..……5 AGRICULTURE (NP)..……6 CLEANING (NP)...……...7 OTHER _____ 8 (SPECIFY)	Q
4.	Does your household own its own rainwater tank? **Ekayawe eine tanka ya maize nge njura?**	YES……..1 NO……2	
	Has your household ever considered building a rainwater harvesting tank to collect water? **Enka yawe yaragizireho ekitekateko kyo kombeka tanka yamaizi nge njura?**	YES……..1 NO……2 DON'T KNOW……998	
	Do you know of other households in the community who have ever considered building a rainwater harvesting tank to collect water? **Haine eka oyorikumanya omukyaro kyanyu eyaratekatekireho okweyombe kyera tanka ya maizi nge njura ?**	YES……..1 NO……2 DON'T KNOW…….998	
5.	How much does the breadwinner in the family get paid for a day of work, on average? (Each day is considered to have 8 working hours) **Omuntu oine entastya omuka, nasha shurwa nka sente zingahe omu izoba ?**	☐☐☐☐☐	
6.	How many households live within 500m of this household? (estimated) **Namaka anga hi agarikutura hahi ne kayawe(500m)?**	☐☐☐ DON'T KNOW……998	

SECTION B: IMPACT OF TANK

1.	How far away is the tank (in metres) ? **Hariho orungyendo ruri kwingana ke kuhika ahatanka(omu metres) ?**	☐☐☐☐	

2.	How much water do you collect from the tank each day (in litres)? **Notaha amaizi garikwinganaki omutanka buri zoba(omu litres) ?**	☐☐☐☐	
3.	How long do you spend collecting water each day? **Nikukutwarira obwire buri kwinganaki kutaha amaizi omutanka buri izoba ?**	☐☐	
4.	Rank the quality of the water from the tank (from 1 to 10). **Gyeragyeranisa oburungi bwamaizi kuruga omu tanka (from 1to 10)** **1 is best quality, 10 is the worst quality.**	☐☐	
5.	What water source did you use before you started using the tank (for general use, not just clean water)? **Okaba nokoresa amaizi gamuringo ki otakatandikire kukoresa aga tanka ?**	PIPED WATER……1 TUBE WELL OR BOREHOLE……...2 DUG WELL PROTECTED WELL……31 UNPROTECTED WELL……..32 WATER FROM SPRING……4 TANKER TRUCK……..5 SURFACE WATER (RIVER/ DAM/LAKE/PONDS/ STREAM/CANAL/ IRRIGATION CHANNEL)……..6 BOTTLED WATER……7 OTHER: _____96	
6.	How far away is this source (in km)? **Hariho arugyendo rurikwinnganaki kuhika ahamaizi aga ?**	☐☐	
7.	How long did you spend getting water from this source (in hours per day)? **Kikaba nikikutwarira obwire burikwingana ki okutaha amaizi aga (in hours per day) ?**	☐☐	
8.	Rank the water quality of this source (from 1 to 10). **Gyeragyeranisa oburungi bwa gamaizi(from 1 to 10)**	☐☐	
9.	Has getting water from the tank helped your household in any other way besides water quality and distance travelled to get water? **Hani okutaha amaizi omutanka oku kyahwerire ekayawe omugundi muringo gutari ogwa amaizi marungi hamwe norugyendo rurigwa rwo kutambura kutaha amaizi ?**	REDUCED DISEASE……1 REDUCED CHANCES OF RAPE……2 REDUCED CHANCES OF ROBBERY……3 OTHER_____ 96	Q
10.	Do you use other sources together with the RWH tank? **Nobasa kuba nokoresa agandi maize hamwe nag a tanka yenjura ?**	YES……..1 NO……2	
11.	Is this the same source as the one you used before getting the tank? **Aga nigo maize gamwe nka gu wabaire nokoresaho enyima ya tanka ?**	YES……..1 NO……2	
12.	If not, what source is it? **Kyaba kitari ekyo okaba nogataha nkahi ?**	PIPED WATER……1 TUBE WELL OR BOREHOLE……...2 DUG WELL PROTECTED WELL……31 UNPROTECTED WELL……..32 WATER FROM SPRING……4 TANKER TRUCK……..5 SURFACE WATER (RIVER/ DAM/LAKE/PONDS/	

		STREAM/CANAL/ IRRIGATION CHANNEL)……..6 BOTTLED WATER……7 OTHER: _____96	

SECTION C: COMMUNITY-LEVEL INSTITUTIONS

	When there is a problem with your main water source, whom do you tell or ask for help? **Habaho ekizibu kyona ahumurikutaha amaizi, nimumanyisa oha ahabwo buyambi ?**	NOBODY……1 WATER MANAGEMENT COMMITTEE……..……..2 PERSON IN THE COMMUNITY RESPONSIBLE FOR MAINTENANCE……..……3 MAINTENANCE WORKER FROM OUTSIDE THE COMMUNITY…4 LOCAL GOVERNMENT……5 MAYOR……6 TRADITIONAL LEADER……..7 RELIGIOUS LEADER……...…….8 OTHER _____ 96 (SPECIFY) DON'T KNOW……998	
	Have you ever contacted this person or group before? **Warabasize kugamba ninga kumanyisa ogumuntu nari egi gurupu enyimaho ?**	YES……..1 NO……2 DON'T KNOW……998	
	Was the person or group helpful? **Ogu muntu nari gurupu haine eki yakuhwerire ho?**	YES……..1 NO……2 DON'T KNOW……998	
	Was the problem solved? **Ekizibu kikahwa?**	YES……..1 NO……2 DON'T KNOW……998	
	Do you know whether anyone else has contacted this person or group for a problem related to your water source? **Haine omuntu wena owu orikumanya awaburize ogumuntu nari gurupu ahabizibu ebikwatirine na amaizi ganyu ?**	YES……..1 NO……2 DON'T KNOW……998	
	Do you ever discuss issues related to water, sanitation, or hygiene with your neighbors? **Hariho obu muri kuganira aha bikwatirine ne bya maizi, obuyonjo, hamwe na bariranwa bawe ?**	YES……...1 NO……2	
	Do you know whether, in the last 12 months, a community meeting has occurred in this village? **Nobasa kuba nomanya omu mwaka oguhwaire, haba harabiremu orukiko rwabataka ?**	YES……..1 NO……2 DON'T KNOW……998	
	During the last 12 months, did you or another member of your household participate in a community meeting? **Omumwaka oguhwaire , iye nari owo mukayawe, haine owaragire omurukiko rwabataka ?**	YES……..1 NO……2	
	Do you know whether, in the last 12 months, people in this village have worked together in a cooperative? **Nobasa kuba nomanya omumwaka oguhwaire, abantu bo mu kyaro baba baine enkoranga emwe ?**	YES……..1 NO……2 DON'T KNOW……998	
	During the last 12 months, did you or another member of your household participate in a cooperative?	YES……..1 NO……2	

	Omumwaka ogwenyi oguhwaire, iye nari owe haine obu mwayejumbire omunkoragana nabataka omukyaro eki ?		
	Do you know whether, in the last 12 months, people in this village have formed a health fund? **Omumwaka gumwe oguhwaire, haine abantu bomukyaro kyanyu barundi neho esente zokuyamba ebyamagara ?**	YES……..1 NO……2 DON'T KNOW…….998	
	Is there a committee or group in the community that is responsible for maintenance of this rainwater tank? **Hari ho akakiko nari gurupu omukyaro eki eine obuvunanizibwa aha kureberera egi tanka ya maize ge njura ?**	YES……..1 NO……2 DON'T KNOW…….998	
	How would you assess the effectiveness of the committee? **Iwe akakakiko kamaizi noreba enkora yako erweta ahabuhereza bwa maize ga tanka yenjura ?**	EXCELLENT……1 GOOD……2 FAIR……..3 POOR……4 DON'T KNOW…….998	
	Are you or another member of your household a member of any of these groups, and do you or the other household member participate in their meetings? **Iye nari owe ekayawe ondijo, haine ori omu za gurupusi kandi iye nari oweka hari ho ri kwejumbira omu nkinko zebyaro ?**	IS A MEMBER……1 PARTICIPATES IN MEETINGS AND OTHER EVENTS…….2 NO MEMBERSHIP OR PARTICIPATION……..3	
	What are the issues dealt with by this group? **Nibintuki ebi gurupu egi eri kukora ho?** CHECK ALL MENTIONED.	CONSTRUCT WATER SUPPLY…...1 CONSTRUCT PUBLIC LATRINES…….2 CONSTRUCT PRIVATE LATRINES…….3 FUNDRAISING……...…4 USER FEES……..5 MAINTENANCE OR REPAIRS…….6 SPARE PARTS……....7 CLEANING……..…8 WATER SHED/SOURCE PROTECTION……..…….9 WATER RIGHTS/ACCESS……...10 WATER DISTRIBUTION……..11 IRRIGATION SYSTEM…….12 OTHER _____ 96 (SPECIFY) DON'T KNOW…….998	

SECTION D: WILLINGNESS TO PAY ASSESSMENT

1.	How much water does your household consume (per month in 20-litre jerry cans?) **Eka yawe nekoresa amaizi gari kwi nganaki (per month in 20 liter jerry can ?)**	☐☐☐☐	
2.	How much are you willing to pay for the maintenance and repair of the tank you are using (per year in UGX)? **Iye bobasa kushashura sente zingahe ezo kureberera zatanka (per year in UGSH)** *Randomize starting point. Take the ID number of household, minus 1, and then multiply by 100. If starting point is accepted, increase by 100 UGX intervals until respondent rejects the number. Record the last accepted	☐☐☐☐☐☐	

	number. If initial starting point is rejected, decrease by 100 UGX intervals until respondent accepts. Record the last accepted number.		
3.	Has anyone approached you to ask you to pay for the maintenance and repair of the tank? **Hariho omuntu wena owa kuhikire ari kukushaba sente zo kureberera nano kukuma gye za tanka ?**	YES……..1 NO……2	
4.	If yes, how often have they asked you (per year)? Yaba nikwe, niki batwarira bwireki kukubuza (per year)	☐☐☐☐	
5.	If you were asked to pay for clean water, would you be willing to pay? **Kuwokushabwa kushashura sente zamaizi gatanka, okagashashura oine okwikiriza ? (Note: clean water in general)**	YES……..1 NO……2	
6.	If you were willing to pay, would you be willing to pay _____UGX for 1 20-litre jerry can of water (in UGX)? **Kuwo kuba nobasa kushashura, okashashura sente zingahe……UGX for 1 20 liter jerry can of water (UGX)** *Randomize starting point. Take the ID number of household, minus 1, and then multiply by 100. If starting point is accepted, increase by 100 UGX intervals until respondent rejects the number. Record the last accepted number. If initial starting point is rejected, decrease by 100 UGX intervals until respondent accepts. Record the last accepted number.	☐☐☐☐	

SECTION E: Interview Evaluation

	WHAT IS YOUR EVALUATION OF THE ACCURACY OF RESPONDENT'S ANSWERS?	EXCELLENT……..1 GOOD…….....2 FAIR……...……...…..3 NOT SO GOOD……...…....4 VERY BAD…….……5	
	WHAT IS YOUR EVALUATION ON THE SERIOUSNESS AND ATTENTIVENESS OF THE RESPONDENT?	EXCELLENT……..1 GOOD…….....2 FAIR……...……...…..3 NOT SO GOOD……...…....4 VERY BAD……...……..……5	
	WHAT QUESTIONS DID RESPONDENT FIND DIFFICULT, EMBARRASSING, OR CONFUSING?	_____ _____ _____	
	WHAT QUESTIONS DID INTERVIEWER FIND DIFFICULT, EMBARRASSING, OR CONFUSING?	_____ _____ _____	
	WHAT QUESTIONS DID RESPONDENT SEEM INTERESTED IN?	_____ _____ _____	
	ADDITIONAL COMMENTS _____ _____ _____ _____		
	RECORD THE TIME.	☐☐ : ☐☐ Hours Minutes	

Institutional Rainwater Harvesting Sustainability Survey for RWH Tank Holders (July 2010)
Progressive Health Partnership/Duke University and Mayanja Memorial Hospital Foundation

IDENTIFICATION

Tank ID…….

Respondent Name_____

Respondent Line Number……

Local Leader Name_____

Sub-County_____

Parish_____

Village_____

INTERVIEW VISITS

	1	2	3
DATE:	Month Day Year	Month Day Year	Month Day Year
SURVEYOR ID:			
RESULT:			
RECORD DATE AND TIME OF NEXT VISIT REQUESTED BY RESPONDENT.	Month Day Year Hours Minutes	Month Day Year Hours Minutes	

INFORMED CONSENT
The informed consent script has been read and the respondent has agreed to participate in the study.

_____
Surveyor's Signature

RECORD THE START TIME

Hours Minutes

RESULT CODES

10 COMPLETED
11 NO ESTABLISHMENT MEMBER PRESENT OR NO COMPETENT RESPONDENT PRESENT AT TIME OF VISIT
12 ENTIRE ESTABLISHMENT ABSENT FOR EXTENDED PERIOD OF TIME
13 POSTPONED
14 REFUSED
15 TANK HAS BEEN ABANDONED
16 ESTABLISHMENT DESTROYED
17 ESTABLISHMENT NOT FOUND
18 OTHER_____
(SPECIFY)

INSTRUCTIONS: AFTER REACHING THE PUBLIC BUILDING, ASK TO SPEAK WITH THE HIGHEST-RANKING LOCAL LEADER.

NOTE: QUESTIONS MARKED WITH 'Q' NEED TO ALSO HAVE ANSWERS MARKED ON THE QUALITATIVE DETAILS SECTION.

SECTION A: GENERAL INFORMATION AND LOCATION CHARACTERISTICS

No.	Question	Answer	Comments
1.	What type of building is this?	SCHOOL……..1 PLACE OF WORSHIP……2 HEALTH-CENTRE…….3 OTHER:_____ 4	
2.	What is the name of the location?	NAME:	
3.	Contact Number	☐☐☐☐☐☐☐☐☐☐	
4.	How old is this establishment (in years)? **Ekyombeko eki kyahitsya bwiire ki?**	☐☐	
5.	How many tanks are located here? **Harimu tanka zingahi omumwanya ogu?**	☐	
6.	How many households live within 500m of this establishment? (estimated) **Ni amaka nka angahi agarikutura omumwanya gwa entambwe 500 okuruga aha?**	☐☐☐	

SECTION B: SPECIFIC LOCATION CHARACTERISTICS

Section B1: Schools

1.	Is this a private school or a public school? **Eishomero eri ni eryabantu ninga erya gavumenti ?**	PRIVATE…….1 PUBLIC……2	
2.	What is the enrolment of this school? **Mwiine abaana bangahi omwishomero eri ?**	☐☐☐	
3.	What was your school enrolment before the tanks were installed? (Write down why enrolment increased/decreased) **Eishomero rikaba ryiine abaana bangahi tanka etakagiireho?**	☐☐☐	Q
4.	How many staff members are part of the school? **Nibangahi omubakozi abarikutura abarikutuura aheishomero?**	☐☐	
5.	How many teachers stay at the school? **Ni abashomesa bangahi abarikutuura ahaishomero?**	☐☐	
6.	How many students stay at the school? **Ni abegi bangahi abarikutuura aheishomero?**	☐☐☐	

Section B2: Place of Worship

1.	How many people attend this place of worship regularly? **Ni abantu bangahi abarikushabira omumwanya ogu burijo ?**	☐☐☐☐	

2.	What was your attendance before the tanks were installed? (Write down why attendance increased/decreased) **Mukaba mwiine abantu bangahi tanka zitakagiireho?**	☐☐☐	
3.	Does the pastor stay at/near the church? **Omuriisa natuura omumwanya ogu ?**	YES……..1 NO……2	
4.	How often do you hold functions outside of regular services (per year)? **Haine obumurikutunga emikoro endiijo etari yaburiijo ?**	☐☐	
5.	How many people attend these functions on average? **Ni abantu nkabangahi abarikwetaba omumikoro egi ?**	☐☐☐☐	
6.	Do you serve them water from the tank? **Nimubaha amaizi agarikuruga aha tanka ?**	YES……..1 NO……2	
7.	How much water do you use at such functions (in hundreds of liters)? **Nimukozesa amaizi garikwinganaki ahamikoro egi ?**	☐☐☐☐	

Section B3: Health Centres

1.	How many patients do you see a week? **Nimureeba abarweire bangahi omusande**	☐☐☐☐	
2.	How patients were seen per week at health centre before the tanks were installed?	☐☐☐	
3.	How many staff members work at the health centre? **Mwiine abakoozi bangahi ahirwariro eri ?**	☐☐	
4.	Is the health centre understaffed? **Mwiine abakozi bakye ?**	YES……..1 NO……2	
5.	Do the health workers stay at/near the health centre? **Abashaho nibatura ahirwariro ?**	YES……..1 NO……2	
6.	How many stay at/near the health centre? **Nibangahi abarikuturaho ?**	☐☐	

SECTION C: SPECIFIC TANK CHARACTERISTICS

REFER TO ATTACHED TABLE

SECTION D: MANAGEMENT AND MAINTENANCE

1.	Do you have a committee that oversees the management of the tank? **Mwiineho akakiiko akarikureberera tanka ?**	YES……..1 NO……2	If NO, go to D11
2.	Who are the committee members? **Nibantuki abari ahakakiiko aka ?** RECORD ALL MENTIONED.	LEADER OF ESTABLISHMENT…...1 MEMBER OF ESTABLISHMENT….2 NIGHT WATCHMAN…….3 STUDENT/CHILD……..4 MEMBER OF COMMUNITY…….5	Q
3.	How many members are there on the committee? **Akakiiko kariho abantu bangahi ?**	☐☐	

4.	How often does the committee meet (per year)? **Akakiiko nikabugana emirundi engahi omumwaka ?**	☐☐☐	
5.	What are the duties of the committee? **Emigasho yakakiiko aka niyo eha ?**	MEETING ☐ REPAIRING TANK ☐ CLEANING TANK ☐ COLLECTING FUNDS ☐ MOBILISING COMMUNITY ☐ OTHER:_____ ☐	Q

6.	Where do funds to maintain/repair the tank come from? **Esente zokureberera tanka nimuziiha nkahi ?**	GOVERNMENT ☐ ESTABLISHMENT ☐ COMMUNITY ☐ OTHER:_____ ☐	Q
7.	If the funds come from government sources, how long do they take to arrive (in months)? **Esente zaaba niziruga omu gavumenti nizitwaara bwiire ki kubahika (omu myeezi) ?**	☐☐	

8.	Do you know how to maintain the tank? **Nimumanya okureberera tanka ?**	YES……..1 NO……2	
9.	Name the ways which you would maintain a tank **Gamba emiringo eyimurikubasa kurebereramu tanka** *Write down the number of ways respondent mentions	☐☐	Q
10.	How many repair contractors do you know of? **Nomanya abantu bangahi abakugaruraho tanka yacweka ?**	☐☐	
11.	Can you name a specific contractor, should major repairs be needed? **Nobasa kungambira oworikumanya ngu nabasa kugigaruraho kuyakucweka ?**	NAME 1: YES……..1 NO……2 NAME 2: YES……..1 NO……2 NAME 3: YES……..1 NO……2	
12.	How often is the tank cleaned a year? **Tankamugiyonja emirundi engahi omumwaka ?**	☐☐☐	
13.	Who cleans the tank? **Nooha orikugiyonja?**	LEADER OF ESTABLISHMENT…...1 MEMBER OF ESTABLISHMENT….2 NIGHT WATCHMAN…….3 STUDENT/CHILD……..4 MEMBER OF COMMUNITY…….5	
14.	Which areas of the tank do you clean? **Nimuyonja bicweka ki bya tanka ?**	TAPS……...1 INSIDE TANK…….....2	

		GUTTERS……..…....3 AROUND TANK…….4 OTHER……..……...5	

SECTION E: IMPACT OF THE TANKS

1.	Where did you obtain water from before you got the tank? **Mukaba mwiiha nkahi amaizi mutakabwiine tanka ?**	PIPED WATER……1 TUBE WELL OR BOREHOLE……...2 DUG WELL PROTECTED WELL……31 UNPROTECTED WELL……..32 WATER FROM SPRING……4 TANKER TRUCK……..5 SURFACE WATER (RIVER/ DAM/LAKE/PONDS/ STREAM/CANAL/ IRRIGATION CHANNEL)……..6 BOTTLED WATER……7 OTHER _____ 8	
2.	How far away was the source (in km)? **Ahi mwabiire nimwiiha amaizi hakaba nihinganaki (omu km)?**	☐☐	
3.	Were there any problems with the water from this source? **Ago maizi haine obuzibu obugabiire gaine?** CHECK OFF ALL THAT APPLY	TASTES BAD……1 DISCOLORED/DIRTY……..2 GERMS/CAUSES DISEASE…….....3 SHARED WITH ANIMALS……..4 INSECTS……..…5 PEOPLE STEP IN……...…6 OTHER _____8 (SPECIFY)	Q
4.	Were there any problems with the water from the rainwater tank? Haine obuzibu obwamiizi ga tanka garabaretiire? CHECK OFF ALL THAT APPLY	TASTES BAD……1 DISCOLORED/DIRTY……..2 GERMS/CAUSES DISEASE…….....3 SHARED WITH ANIMALS……..4 INSECTS……..…5 PEOPLE STEP IN……...…6 OTHER _____8 (SPECIFY)	Q
5.	Where do you obtain water from when the tank runs out? **Nimwiiha nkahi amaizi agomutanka gahwamu?**	PIPED WATER……1 TUBE WELL OR BOREHOLE……...2 DUG WELL PROTECTED WELL……31 UNPROTECTED WELL……..32 WATER FROM SPRING……4 TANKER TRUCK……..5 SURFACE WATER (RIVER/ DAM/LAKE/PONDS/ STREAM/CANAL/ IRRIGATION CHANNEL)……..6 BOTTLED WATER……7 OTHER: _____ 8	

6.	How far away was the other source (in km)? **Hakaba nihinganaki (omu km)?**	☐☐	
7.	Were there any problems with the water from this other source? **Amaizi ago gakaba gaine obuzibu bwoona?** CHECK OFF ALL THAT APPLY	TASTES BAD……1 DISCOLORED/DIRTY……..2 GERMS/CAUSES DISEASE……....3 SHARED WITH ANIMALS……..4 INSECTS……..…5 PEOPLE STEP IN……...…6 OTHER _____8 (SPECIFY)	Q
8.	If you share the water from the tanks with the community, has there been any disruption to your work when the general population comes to get water? **Mwaba nimukozesa amaizi aga nabantu boona, hiine okukyabateganiise ahamirimo yanyu abantu aba kubarikwiija kutaha amaizi?**	YES……..1 NO……2	
9.	How is your work disrupted? **Nikibateganisa kita omumirimo yanyu?**	CLASS/WORK INTERRUPTED…….1 NEED TO SUPERVISE COMMUNITY MEMBERS……2 NOISE……...3 OTHER _____8 (SPECIFY)	Q Give us some examples.
10.	How often does this disruption occur (per week)? **Okuteganisibwa oku nikubaho emirundi engahi omusande?**	☐☐	
11.	Do you find solutions to overcome these disruptions? **Nimuronda emiringo yokumaraho okuteganisibwa oku?**	YES……..1 SOMETIMES……...2 NO……3	Q How do you overcome this disruption?

SECTION F: DEMAND MANAGEMENT

7.	What is water from the tank used for? **Amaizi agumurikwiiha omu tanka nimugakozesa ki?** NON-POTABLE USES OF WATER MARKED AS NP.	DRINKING……...1 BATHING……2 HANDWASHING…….3 COOKING…….4 ANIMALS (NP)...…….5 AGRICULTURE (NP)..……6 CLEANING (NP)...……...7 OTHER _____ 8 (SPECIFY)	Q
8.	*Check Y if the water is used for non-potable purposes (MARKED AS NP).	YES……..1 NO……2	
9.	How much water is drawn out from the tank each day (in liters?) **Amaizi agari kutahwa omutanka burizoba nigingana ki?**	☐☐☐☐	
10.	Who decides how much water to give out? **Noha ori kusharamu amaizi gokutaha okugari kwingana?**	COMMITTEE……...1 COMMUNITY REQUEST……...2 LEADER OF ESTABLISHMENT…...3 OTHER _____ 8 (SPECIFY)	

11.	What is the process for decision? **Nitwazaki erikugyenderwaho kusharamu amaizi gokutahwa?**	CONSENSUS BY COMMITTEE……1 VOTING BY COMMITTEE……2 CONSENSUS BY COMMUNITY…...3 VOTING BY COMMUNITY……...4 CHAIRMAN OF ESTABLISHMENT DECIDES……..5 LEADER OF ESTABLISHMENT DECIDES……..6 OTHER _____ 8 (SPECIFY)	Q Give details
12.	How is water distributed? **Amaizi nigahebwa gata?**	FIXED AMOUNT……1 NO LIMIT……....2 VARIES WITH SEASON……....3 VARIES WITH WATER LEFT IN TANK……4 OTHER _____ 8 (SPECIFY)	Q
13.	How many people from the establishment use water from the tank from the establishment? **Ninka bantu bangahi abari kutaha amaizi omutanka etekatekirwe ?**	☐☐☐	
14.	Is water from the tanks shared with the community? **Amaizi gomu tanka nigatahwaho nabandi bantu bo mukyaro eki ?**	YES……..1 NO……2	If NO, go to F10.
15.	How many people from the community use water from the tank? **Ni abantu bangahi abomukyaro eki abarikutaha amaizi gomutanka?**	☐☐☐	
16.	Does the tank go dry? **Amaizi gomutanka hariho obugarikuhwamu?**	YES……..1 NO……2	If NO, end this section.
17.	How many days a year is the tank dry? **Namazoba angahi agu tanka erikuba ehwiremu amaizi omumwaka?**	☐☐☐	

SECTION G: RELATIONSHIP WITH THE COMMUNITY

1.	Does the establishment have disputes with the community? **Hine nkoku abarikukoresa amaizi baine oku batarikwetegyerezana nabantu bomukyaro eki ?**	YES……..1 NO……2	If NO, go to G3
2.	How often has your establishments had disputes with the community (in a year)? **Nikitwara obwire buri kwinganaki abu orikutaha nabo amaizi barikugira emparana nabantu bomukyaro enki ?**	☐☐☐☐	Q
3.	Disputes over water from the tank? **Emparana zamaizi gomutanka ?**	YES……..1 NO……2	If NO, go to G5
4.	How often do disputes over water from the tank occur (in a year)? **Nikimara bwire ki emparana zamaizi gomu tanka zikubaho(omumwaka)?**	☐☐☐☐	
5.	Does the community ask for water? **Abantu bomukyaro eki nibashaba amaizi ?**	YES……..1 NO……2	If NO, go to G7
6.	How often does the community ask for water (in a month)? **Nikitwara bwire burikwinganaki abantu bo mukyaro eki kushaba amaizi ?**	☐☐☐	
7.	Do parents/community members contribute money to the establishment?	YES……..1 NO……2	If NO, go to G9

	Abazaire na bantu bomukyaro eki nibarundana sente zoku yamba abari kutaha amaizi?		
8.	What percentage of parents/community members contribute money? **Nimuhendo ki gwa bazaire/ abantu bo mukyaro eki abari kurundana sente ?**	☐☐	
9.	What percentage of parents/community members attend meetings organized by the establishment? (PTA meetings, functions etc) **Nimuhendo ki gwabazaire /abantu bomukyaro eki barikuza omunkiiko ezi tebekanisibwe abatahi bamaizi ?**	☐☐	
10.	On average, how far away do pupils/community members stay (in km)? **Okutwariza hamwe abantu bomukyaro eki nibatura ahari kwi nganaki kuruga ahatanka yamaizi eri ?**	☐☐☐	

QUALITATIVE DETAILS

For questions marked with a 'Q', please record any answers given that are not captured by the answer format given in the previous sections.

SECTION D

4. Who are the committee members?
   Abakakiiko abo nibaha?

7. What are the duties of the committee?
   Emirimo yakakiiko ako niyo eha?

8. Where do funds to maintain/repair the tank come from?
   Esente zokureberera/okukanika tanka niziruga nkahi?

14. Name the ways which you would maintain a tank
   Gamba emiringo eyiwakurebereramu tanka

SECTION E

3. How would you rate the quality of this water (on a scale from 1 to 10)? (Write other attributes described)
   Okarenga ota oburungi bwamaizi.

4. How would you rate the quality of the water from the tank (on a scale from 1 to 10)? (Write other attributes described)

7. How would you rate the quality of this water (on a scale from 1 to 10)? (Write other attributes described)

9. How is your work disrupted? Give us some examples.

11. Do you find solutions to overcome these disruptions? How do you overcome this disruption?

SECTION F

1. What is water from the tank used for?

5. Who decides how much water to give out? What is the process for decision?

6. How do you decide how much water to give out?

SECTION G

2. How often has your establishments had disputes with the community (in a year)?

Other Questions

_____

_____

_____

_____

_____

_____

_____

SECTION L: Interview Evaluation

	WHAT IS YOUR EVALUATION OF THE ACCURACY OF RESPONDENT'S ANSWERS?	EXCELLENT……..1 GOOD…….....2 FAIR……...……...…..3 NOT SO GOOD……...…...4 VERY BAD…….……5	
	WHAT IS YOUR EVALUATION ON THE SERIOUSNESS AND ATTENTIVENESS OF THE RESPONDENT?	EXCELLENT……..1 GOOD…….....2 FAIR……...……...…..3 NOT SO GOOD……...…...4 VERY BAD……...……..……5	
	WHAT QUESTIONS DID RESPONDENT FIND DIFFICULT, EMBARRASSING, OR CONFUSING?	_____ _____ _____	
	WHAT QUESTIONS DID INTERVIEWER FIND DIFFICULT, EMBARRASSING, OR CONFUSING?	_____ _____ _____	
	WHAT QUESTIONS DID RESPONDENT SEEM INTERESTED IN?	_____ _____ _____	
	ADDITIONAL COMMENTS _____ _____ _____ _____		
	RECORD THE TIME.	☐☐ : ☐☐ Hours Minutes	

SECTION C: SPECIFIC TANK CHARACTERISTICS

Tank Number	Skip Pattern	01	02
Is the tank functional?	If YES, go to C3. If NO, go to C2	YES……..1 NO……2	YES……..1 NO……2
If non-functional, how long has it been non-functional? RECORD IN DAYS.		☐☐☐☐	☐☐☐☐
What is the capacity of the tank (in liters)?		☐☐☐☐☐☐	☐☐☐☐☐☐
How old is the tank (in years)?		☐☐	☐☐
Who built the tank?		SELF_BUILT…….1 GOVERNMENT…..2 NGO…….3 CAMPAIGNER…….4 COMMUNITY…….5 OTHER_____8	SELF_BUILT…….1 GOVERNMENT…..2 NGO…….3 CAMPAIGNER…….4 COMMUNITY…….5 OTHER_____8
What type of tank is it?		FERRO-CEMENT…….1 PLASTIC……...2 MASONRY……...3 UNDERGROUND…….4 OTHER_____8	FERRO-CEMENT…….1 PLASTIC……...2 MASONRY……...3 UNDERGROUND…….4 OTHER_____8
Has this tank been broken before?	If YES, go to 8 If No, end SECTION C	YES……..1 NO……2 DON'T KNOW……8	YES……..1 NO……2 DON'T KNOW……8
How was it broken?		OWN USE……1 COMMUNITY USE……..2 STUDENTS PLAYING…….…….....3 ACCIDENTAL..…….....4 SABOTAGE……...5 OTHER_____8	OWN USE……1 COMMUNITY USE……..2 STUDENTS PLAYING…….…….....3 ACCIDENTAL..…….....4 SABOTAGE……...5 OTHER_____8
Which part required fixing?		TAP……1 TANK WALL…….....2 GUTTER…….....3 PIPE…….4 OTHER……..……..5	TAP……1 TANK WALL…….....2 GUTTER…….....3 PIPE…….4 OTHER……..……..5
How often has it been broken before?		☐☐	☐☐
*Calculate frequency of breakage per year: Incidents divided by years		☐☐	☐☐
How much have repairs cost in total? (in UGX)?		☐☐☐☐☐☐	☐☐☐☐☐☐
How much do you estimate it will cost to perform repairs per year?		☐☐☐☐☐☐	☐☐☐☐☐☐