



# **Quantifying the Impact of Community Social Capital on Sustainable Development in Uganda:**

The influence of water user committees in mitigating deterioration of household access to safe water

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## **Abstract**

**Background:** while access to safe water in Uganda increased between the early 1990s and 2010, current studies are showing that many safe water sources are not being properly maintained and so end up being abandoned. Since the maintenance of safe water sources is under the jurisdiction of water user committees (WUCs), this study seeks to measure the ability of water user committees in mitigating a deterioration in access to safe water. The overall aim is to explore the impact of social capital (represented by the WUCs) on sustainable development (represented by changes in access to safe water).

**Methodology:** Household level data was obtained from the most recent Uganda National Panel Survey (2013/2014). The survey collected information on 3,123 households, and this paper's data was taken from section 9 of the survey- *Housing Conditions, Water and sanitation*, which has 3119 cases. The types of analysis conducted were descriptive statistics, chi-square tests, mood's median test and ordinal logistic regression.

**Findings:** ten and 35 percent of households reported a deterioration and improvement, respectively, and 54.7 reported no changes in access to safe water. Households in communities with WUCs were found to be 52 percent less likely (OR=0.48, p-value <0.05, 95% CI from 0.42 to 1.03) to report a deterioration in access to safe water. However, the added advantage of having a WUC does not change the probability of reporting a deterioration in a major way since the estimated probability of reporting a deterioration when there is a WUC is just below 10 percent, and without a WUC is just above 10 percent.

**Discussion and Conclusions:** local water management through WUCs is a weak contributor to sustainability of safe water access in the context of Uganda. The results indicate that the influence of a WUC seems to be limited. The government and NGOs need to play a more prominent role in helping communities maintain their water sources through more innovative approaches, such as copayments.

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**Abbreviations**

CBM- community based management

CWM- community water management

NTDs- neglected tropical diseases

O&M- operation and management

UN- United Nations

UNICEF- United Nations Children's Fund

UNSDGs- United Nations Sustainable Development Goals

WHO- World Health Organization

WUCs- water user committees

# Introduction

## Water and Public Health

Lack of access to safe water has been linked to poor hygiene and to health problems caused by the consumption of contaminated water (SPHERE, 2011, WHO, 2016, Cairncross and Valdmanis, 2006). The World Health Organization (WHO) estimates that currently, 663 million people rely on unimproved water sources (not protected from contamination), and that globally, approximately 1.8 billion people use a drinking-water source contaminated with faeces (WHO, 2016). Contaminated water is linked to the transmission of preventable infectious diseases such as cholera, typhoid and diarrhea (Fogden, 2009, WHO, 2016, Cairncross and Valdmanis, 2006) that have a negative impact on the public's health. Unsafe water is also a major cause of mortality. For example, the World Bank estimates that 88 percent of diseases in the developing world are caused by unsafe drinking water (Fogden, 2009), and diarrheal diseases due to contaminated water are responsible for 502,000 thousand deaths annually (WHO, 2016). Furthermore, lack of access to safe water also acts as a major barrier in addressing neglected tropical diseases (NTD), which affect one billion people worldwide (Boisson et al., 2016, Baguma et al., 2013).

A lack of access to safe water affects not only individual health, but also directly impacts the health system. It is estimated that 38 percent of health care facilities in low and middle income countries lack access to an improved water source, and that 35 percent lack water and soap for handwashing, which puts both patients and staff at the risk of infection (WHO, 2016, WHO/UNICEF, 2015). Lack of access to safe water in health facilities means that even the institutions that are supposed to help restore people's health can become disease hubs in and of themselves, which has detrimental impacts on the public health.

Exacerbating the situation is the predictions of future scarcity of safe water globally. Fogden (2009) states that a rapid increase in demand for safe fresh water sources coupled with a rapid decrease in supply in recent years have been linked to chronic water shortages. It is estimated that by 2025, 1.8 billion people worldwide will be living in countries or regions with absolute water scarcity, and that two-thirds of the world population could be under water stress conditions (not having enough to meet daily needs) (Fogden, 2009, WHO, 2016). These shortages are most likely to affect the most economically disadvantaged (in both developed and

developing nations) as they lack the resources needed to pay water fees. Worse still, water fees are projected to be rising rapidly (Fogden, 2009).

In July 2010, the United Nations (UN) General Assembly recognized the human right to water and sanitation, and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights, including the right to health (Naiga et al., 2015, WHO, 2016). In the 2015 UN Sustainable Development Goals (UNSDGs), goal 6 deals explicitly with ensuring not only availability, but also sustainability of access to safe water. Target 6B is to: “Support and strengthen the participation of local communities in improving water and sanitation management” (UN-DESA, 2016). This target seeks to ensure that the beneficiaries are involved in the operations and management of water sources as a way of ensuring sustainability. This paper measures the impact of this type of community level involvement in local water management, and assesses whether this community involvement can truly be a contributor to sustainability of safe water access in the context of Uganda.

Fogden (2009) states that International monitoring organizations define “access” to safe water as the availability of at least 20 liters per person per day from an “improved” source within one kilometer of the user’s dwelling. The *Humanitarian Charter and Minimum Standards* published by SPHERE (2011), defines access as: all people have safe and equitable access to a sufficient quantity (7.5 to 15 liters per person per day) of water for drinking, cooking and personal and domestic hygiene; public water points are sufficiently close (maximum distance of 500m/0.25kms) to households; and that water sources and systems are maintained such that appropriate quantities of water are available consistently or on a regular basis. The amount of time it takes from the household to the water source is also an important indicator, but it was excluded from this paper as it is highly dependent on who is collecting the water (example a child versus an adult, in that the child would most likely walk slower than the adult). A mother’s level of education is a household level indicator that has been linked to developmental outcomes such as infant mortality and malaria preventions efforts (Zurovac et al., 2006, Choudhury, 2015). Since women carry the burden of household labor, including water fetching (Baguma et al., 2013), the paper seeks to explore if this household level social capital (education) variable influences changes in access to safe water for their household.

## **Lack of access to safe water in Uganda**

Uganda is a low-income country located in east Africa. It is endowed in fresh water resources because it has a rich network of lakes, rivers, wetlands, rain and ground water. Approximately 16 percent of total land area is made up of wetlands and open water, plus an annual water supply of 66 km<sup>3</sup> in the form of rain and inflows (Nsubuga et al., 2014). However, while Uganda has a rich supply of fresh water sources, the spatial and temporal distribution of these water resources is uneven, leaving some areas such as those in the north-east and south-west with inadequate water resources, and those in the central with plenty. *Figure 4* in appendix I shows how availability of fresh water has changed (decreased between 2001 and 2015), and the differences between the regions. Some of the factors that have been cited in the literature as having a direct impact on changing water availability are: rapid population growth and improving living standards; spatial and temporal variability in precipitation; deterioration in the quality of surface and ground water due to pollution; and changes in land-use, especially deforestation (Nsubuga et al., 2014, Fogden, 2009).

According to 2015 data, only five percent of Ugandan households have water piped directly to their homes (WHO/UNICEF JMP, 2015), leaving 95 percent of the population reliant on communal level sources. Ugandan households that cannot afford private water to their homes are provided safe water sources at the community level. However, there are discrepancies between the official government records, and research findings about the availability and functionality of these sources. The WHO and UNICEF both report that over two thirds (75 percent) of Ugandans have access to safe water (UNICEF, 2014, WHO/UNICEF JMP, 2015). However, a study by van den Broek and Brown (2015) in Masindi and Kiryadongo districts found that only 40 percent of communal safe water sources were functional. Official records for this region showed this number to be 78 percent, revealing a 38 percent point overestimation of safe water access in official records. It is therefore safe to estimate that well over a third (33 percent) of the population still lacks access to safe water.

Furthermore, 67 percent of the population uses either unimproved sanitation facilities, or open defecation, and 14 percent use shared facilities (WHO/UNICEF JMP, 2015). These sources of sanitation have been cited as causes of water contamination since human waste is not properly disposed, or facilities are easily abandoned for open defecation (Choksi, 2015, Cairncross and Valdmanis, 2006).

Due to widespread lack of access to safe water, preventable infections such as diarrheal diseases, are among the top four leading causes of mortality in the country. Uganda is also among the top 30 countries world wide with the highest under five mortality rates. One of the major contributors to this is diarrheal diseases; the birth and under-five mortality rates for households without access to safe water are twice as high as in those households with adequate access to safe water (Naiga and Penker, 2014).

### **From a supply to a demand driven approach to water provision**

During the 1980s, international development agencies pushed for a centralised water supply system (Gasteyer and Araj, 2009). As a result, the water sector in Uganda was centralised, with the government solely responsible for the provision of water. This model has been referred to as the ‘supply-driven approach’, in which water users had limited or no involvement in water provision efforts (Naiga and Penker, 2014, Nsubuga et al., 2014). However, the supply-driven approach failed to achieve its intended results of increasing access to safe water in many countries (Gasteyer and Araj, 2009), and so the in the early 1990s, due to international pressure to decentralise, Uganda’s water sector went through major reforms that led to a shift from a supply-driven to a ‘demand-driven approach’. In this approach, water users were expected to be actively involved in water provision. For example, they were expected to financially contribute to the construction of safe water sources, and be responsible for their operation and maintenance (O&M). It was theorized that under the demand-driven approach, community participation in the initial stages of water provision would be a key to long-term sustainability (Naiga and Penker, 2014).

The demand-driven approach shifted the responsibility for safe water provision from the central government to the districts, with expected explicit support from lower level authorities and local communities at the grassroots. Other actors that were envisioned to work alongside the districts, local authorities and communities were non-governmental organisations (NGOs), private enterprises and development partners (such as UNICEF) (Golooba-Mutebi, 2012). Any actor (community members, NGOs or private companies) that wanted access to a communal safe water point needed to express this need through a written application and send it to the district through the local authorities. As mentioned above, applicants were required to make an up-front contribution towards initial capital costs, to provide the land where the water source would be located, and to operate and maintain the infrastructure once it was installed. The shift was a

tremendous success; according to the Uganda Bureau of Statistics (UBOS), access to an improved water source increased from 44 percent in 1990 to 60 percent in 2004 and to approximately 66 percent in 2010 (Naiga et al., 2015, Nsubuga et al., 2014). Data from 2015 shows that 75 percent of the Ugandan population has access to either piped or an improved water source (WHO/UNICEF JMP, 2015). However, as discussed earlier, there is some doubt about the accuracy of these figures.

Community water sources in Uganda are under the management of water user committees (WUCs), which are elected by the community. As mentioned in the previous section, the 2015 UNSDGs target 6B directly mandates support of these WUCs as essential to sustainability of access to safe water. To assist communities (usually a village) in the process of acquiring an improved water source, it was required that they elect a water user committee (WUC) that could oversee both the initial request and the maintenance of the water source. Therefore, theoretically, the community participated in both the initial and final processes of water provision, and this local collective action from water users (represented by the WUC) was expected to be a major contributor in the ability of the communities to organise and mobilise resources to operate and maintain (sustain) the infrastructure (Naiga et al., 2015).

### **Scope of this Paper**

The overall aim of this paper is to measure the impact of social capital (represented by WUCs) on sustainable development (represented by changes in access to safe water). The outcome variable is household reported changes in access to safe water, measured across three ordinal levels- improved, same and deteriorated. The research question is “Does community social capital, as represented by WUCs, have a major influence over household sustainable access to safe water?” The hypothesis is that households that live in a community that has a WUC have lower odds of reporting a deterioration in access to safe water.

## **Social Capital**

### **Theory of collective efficacy**

The results of this paper are best understood through the lens of collective efficacy theory. Collective efficacy is the willingness of residents to work together for mutual benefit, and requires mutual trust and solidarity among residents (Kawachi et al., 2008). Collective efficacy

affects public health in that it can determine how people organize for sustained public action against neighborhood hazards (ibid.). The creation and continued functionality of the WUCs requires sustained collective action. There is supportive evidence pointing to the fact that decisions on whether to cooperate with others to achieve a collective goal is made within the context of pre-existing social relations and networks (Bisung et al., 2014, van den Broek and Brown, 2015, Kawachi et al., 2008, Bisung and Elliott, 2014). For example, Bisung and Elliott (2014) cite a study by Mudege and Zulu (2011) carried out in Nairobi slums. The authors found that pre-existing intra-community conflicts between households of different socio-economic status had a negative effect on collective action to address water issues. Since Uganda is multi-ethnic country with a history of political and ethnic conflict (Kibanja et al., 2012), as well as large disparities between the rich and poor, the theory of collective efficacy provides a relevant conceptual understanding of the findings of this paper.

### **Social Capital Definitions and Measurement**

Social capital has been given various definitions depending on the level of analysis chosen, and the most prominent scholars on theories and definitions are Bourdieu and Putnam (Bhandari and Yasunobu, 2009, Bhuiyan, 2011, Acquaah, 2014). Bourdieu conceptualized social capital as an individual resource that was dependent on individual attributes, such as education, that facilitate the ability to accumulate and access scarce resources (Kawachi et al., 2008, Bhandari and Yasunobu, 2009). On the other hand, Putnam conceptualized social capital as a communal resource that comprised of networks, norms, and trust that facilitate action and co-operation for mutual benefit (Kawachi et al., 2008, Acquaah, 2014). There have been convincing arguments from subsequent scholars advocating for either side. The fundamental concept, however, is that social capital is about incorporating socio-cultural factors in explanations of developmental outcomes (Bisung et al., 2014, Bhandari and Yasunobu, 2009, Acquaah, 2014, Bisung and Elliott, 2014).

There are three types of social capital: 1) structural (ex. social networks and civic engagement); cognitive (ex. shared norms, values, trust and cooperation); and 3) relational (bonding, bridging and linking, horizontal and vertical, and strong or weak). The literature shows that social capital is an attribute of both an individual and a society, and so therefore the three types can be measured on either individual or collective levels, depending on the purposes of the study (Bhandari and Yasunobu, 2009, Acquaah, 2014). Measurement of social capital can also

be micro, meso or macro. Micro measures of social capital focus on the norms, values and trust between individuals and households that facilitate interactions and cooperation (Bhandari and Yasunobu, 2009). This paper is based on micro measurement and comparison of collective/community social capital using individual household data. The construction of safe water points in Uganda required only a combination of relational vertical and structural (civic engagement) social capital, but their maintenance requires a prominent level of cognitive social capital (shared norms and goals, as well as trust and cooperation for collective action).

Bhandari and Yasunobu (2009) cite Coleman (1990) who asserts that social capital is an aspect of a social structure that facilitates certain actions of individuals who are within that structure; thus, social capital is a productive resource that facilitates the achievement of certain ends that would be impossible in its absence. Bhuiyan (2011) compliments this idea and asserts that social capital is a resource that can contribute towards sustainable development.

Furthermore, Bhandari and Yasunobu (2009) also cite Fukuyama (2001), who argued that cultural norms and values influenced the ability to create and manage institutions. WUCs, as an institution, can be seen as an outcome of social capital since their formation required a certain level of civic engagement and community participation that eventually led to the election of the committee (Acquaah, 2014). However, in the case of Uganda, many WUCs were elected due to the strong presence of NGOs that pushed the work forward (van den Broek and Brown, 2015). Therefore, the presence of functional WUCs is more important to measure, since at the moment there is no evidence of NGOs manipulating WUCs continued functionality (van den Broek and Brown, 2015). Consequently, a functional WUC, as an outcome of local collective action, is used as a proxy for the presence of collective efficacy in the community. This collective action, in turn, facilitates sustainable development (Acquaah, 2014, Kawachi et al., 2008, Bhandari and Yasunobu, 2009). For the purposes of this paper, the idea is that social capital is necessary for both initial and sustained collective action for access to safe water. Particularly, the assertion is that a functioning of WUCs is an outcome of collective action that mitigates a deterioration in access to safe water.

## **Data and Methodology**

### **The Uganda National Panel Survey**

Data for this study was obtained from the Uganda National Panel Survey (UNPS) 2013/2014 found on the World Bank website (Uganda Bureau of Statistics, 2017). It is the fourth in a series of surveys done since 2009/10, and is used to track and re interview 3,123 households. The geographic locations of the households to be included were chosen through equal probability sampling and implicit stratification along urban/rural and district information. The households themselves were then randomly selected through clustering, with each cluster representing a group of households that are within a particular geographic area up to the parish level (Uganda Bureau of Statistics, 2016).

The UNPS is a nationally representative annual multi-topic household survey designed as a tool to inform policy-making, and aims at producing annual estimates on key policy areas. It therefore provides a platform for experimentation and assessment of national policies and programs (Uganda Bureau of Statistics, 2016). The Uganda Bureau of Statistics (UBOS) is responsible for the implementation of the UNPS program, with financial and technical support from the Government of Uganda, the Government of Netherlands, and the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) project.

The UNPS data is collected through six different questionnaires: Household Questionnaire; Woman Questionnaire; Agriculture Questionnaire; Fisheries Questionnaire; Community Questionnaire and Market Questionnaire. This study used data found in the household questionnaire, specifically section 9- *Housing Conditions, Water and sanitation*, which has 3119 cases and 31 variables. The survey does not explicitly state who the respondents are, but notes that the parents are the primary respondents, with preference given to the mother. Data from this section was aimed at measuring the quality of housing, and information was collected on the type of dwelling, occupancy status, the physical characteristics of the dwelling, and access to basic services such as water, electricity and sanitation.

#### **Variable Selection**

The outcome is changes in access to safe water (since 2008), and the principle independent variable is WUCs (which are tasked with O&M for the water source). The control variables are purpose of water fees (since WUC must collect maintenance fees), distance

between water source and household, mother's level of education, and main constraints to access as identified by each household.

## **Data Management**

Section 9 is found in data file GSEC9\_1, and was combined with data file GSEC3 to obtain information on mother's level of education (see table 1). The changes in access to safe water variable (which is the outcome of interest) was recoded into 2, 1, and 0, representing deteriorated, same and improved, respectively, and the measure was changed from nominal to ordinal to allow ordinal logistic regression to be conducted. While logically it may seem that the levels are labelled in reverse order, this order facilitates interpretation since the outcome of interest is deterioration, not improvement. Households that did not know what changes in access had taken place (n=53) were recoded as missing. For WUCs, which is the main predictor variable, there were three categories (yes, no, don't know); the "no" and "don't know" categories were recoded into one category, and the variable was given new values, 0 for "no" and 1 for "yes". The combination of the 'don't know' with 'no' category is not expected to affect the results since the aim is to assess if the presence of a WUC (yes category) mitigates a deterioration in access to safe water.

The recoding of the covariates used in the study will now be presented. The variable 'purpose of user fees' was related another variable 'do you pay for water' that is not presented here. The paper analyses only those houses that said that they pay for their water, whether privately or through fees to the WUCs. Purpose of payments had a third category called 'other', which was combined with user fees/tariffs category because the interest for the analysis is the maintenance costs. Households can have piped water to their homes, in which case they pay user fees for this service. Since the study seeks to assess water sources maintained by the WUC for the community at large, private funding for private water sources needed to be excluded. Essentially, the study will assess the proportion of WUCs that also collect a maintenance fee. The variable was recoded into 0 (user fees/tariffs, collected by private enterprises) and 1 (maintenance costs, collected by WUCs). Mother's level of education, the individual level household social capital variable was recoded as: No formal education/less than primary/don't know (0); Primary completed/some (1); Secondary completed/some (2); Post secondary training (3). Finally, there was a category that asked for the main constraints that a household faces in

accessing safe water. Some of the constraints identified were that there was no problem (coded as 0), long distance (1), inadequate source (2) and other (3). The ‘other’ category included issues such as high-costs and insecurity.

## Analysis Methods

The data was analysed using IBM SPSS Statistics 22, and the types of analysis included descriptive statistics, chi-square test, Mood’s median test, and ordinal logistic regression. Chi-square and mood’s median tests are bivariate analysis methods that assess the relationship between two variables. Ordinal regression on the other hand, simultaneously considers the effects of a set of explanatory variables across all the levels of the outcome. Phi and Cramer’s V coefficients, Test of Parallel Lines, and Model Fitting Information were used to assess the robustness of the bivariate analysis and ordinal regression.

Ordinal logistic regression assumes that the odds across the levels of the outcome are proportional, and therefore measures the cumulative probability of being at a given level of the outcome, and all below it (Strand et al., 2011, Norušis, 2009). The equation that SPSS used for the regression model presented in *Table 3* is expressed as:

$$\text{Log(odds)} = \alpha_j - B_i X_i + B_{ii} X_{ii} + B_{iii} X_{iii}$$

The  $\alpha$  is the constant, and  $j$  represents the number of categories, minus 1. The minus sign before the coefficients for the explanatory variables is done so that positive coefficients are associated with high outcomes (same to deterioration), and negative coefficients are associated with low outcomes (same to improved). For a continuous variable (distance), a positive coefficient means that as the values of this variable increase, the likelihood of a higher outcome scores increases. The B is the coefficients of the explanatory variables, and the X is that variable. The  $X_i$  is distance,  $X_{ii}$  is WUCs, and  $X_{iii}$  is mother’s level of education.

## Model Comparison

When deciding which model best explains the relations between changes in access to safe water and WUCs, a few things were considered: 1. loglikelihood (how the model improves predictive power above chance); 2. model fitting information (how well the model fits the data); and most importantly, 3. the test of parallel lines (ensures that the proportional odds assumption

is met) (Strand et al., 2011). The models presented below were compared to the regression model presented in the results, and this sub-section explains why these models were rejected.

**Model with WUC, distance, mother's education, and main constraints:** While this model's loglikelihood showed that it improved predictive power, that the Nagelkerke R-squared explained 13.8 percent of the variation in data, and that the model fits the data well (p-value = 0.58), the proportional odds assumption was not met (p-value=0.01). The proportional odds assumption must be satisfied for any ordinal regression model to be valid (Strand et al., 2011, Norušis, 2009).

**Model with WUC, mother's education, and main constraints:** in this model, neither the proportional odds assumption nor the model fitting was satisfied, even though it explains a larger variation in data, with Nagelkerke of 14.9 percent.

**Model with WUC, distance and main constraints:** this model too explains 14.9 percent of the variation in data, but it does not fit the data well (p-value=0.00), and the proportional odds assumptions is also not met (p-value=0.05).

Therefore, the three above models were rejected because they not only fail to satisfy the proportional odds assumption, but also either do not fit the data well, or do not improve predictive power above chance.

## Descriptive Statistics

*Table 1* shows that more than half (54.7 percent) of the households in the sample reported no changes in access to safe water, 35.1 percent reported an improvement, while 10.2 percent reported a deterioration. Furthermore, more than half (53.3 percent) of households live in communities whose water sources are managed by WUCs. However, only 44.1 percent of water fees collected are for maintenance purposes, meaning that most households that pay for water do it for private water provision.

Less than 20 percent of mothers reported having achieved at least some secondary education, and 43.9 percent indicated that they had little or no education. Approximately 33 percent of households also indicated that they experienced no problems in accessing safe water, and 31 percent identified inadequate sources as a main constraint. Finally, the minimum and maximum distance from the household to the water source is between 0 and 20kms, with an

average distance of 0.72kms. This average distance is on the higher range of what has been recommended by international organizations.

*Table 1- Descriptive Statistics*

Variable	Category	Valid N	Valid %	Mode	
	<b>Total</b>	<b>2022</b>	<b>100</b>	<b>1</b>	
<b>Changes in access to safe water</b>	Improved	709	35.1		
	Same	1107	54.7	*	
	Worsened	206	10.2		
	<b>Total</b>	<b>3118</b>	<b>100</b>	<b>1</b>	
<b>Safe Water sources managed by WUCs</b>	No	1455	46.7		
	Yes	1663	53.3	*	
	<b>Total</b>	<b>1093</b>	<b>100</b>	<b>0</b>	
<b>Purpose of water fees</b>	User fees/tariffs	611	55.9	*	
	Maintenance costs	482	44.1		
	<b>Total</b>	<b>5412</b>	<b>100</b>	<b>0</b>	
<b>Mother's level of education</b>	None/Little/Unknown	2377	43.9	*	
	Primary Completed/Some	1995	36.9		
	Secondary Completed/Some	808	14.9		
	Post Secondary Training	232	4.3		
	<b>Total</b>	<b>3119</b>	<b>100</b>	<b>0</b>	
<b>Main constraints to access</b>	No problem	1034	33.2	*	
	Long distance	852	27.3		
	Inadequate sources	968	31		
	Other	265	8.5		
	<i>* category is the mode</i>				
<b>Distance (kms)</b>	<b>Valid.N</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>SD</b>
	2703	0	20	0.72	1.012

## Results

### Bivariate Analysis

The chi-square test of independence was performed for changes in access to safe water and the categorical predictor variables, and the Phi (for 2x3 tables) and Cramer's V (for 3x4 table) coefficients were used to assess the strength of the evidence. *Table 2* below shows that there are significant associations ( $p\text{-value} < 0.05$ ) for both WUCs ( $\text{chi-sq.} = 108.46$ ) and purpose

of payments (chi-sq.= 7.66). The strength of the evidence, as indicated by the phi-coefficient (WUCs=0.23 and purpose of payments=0.11) is moderately strong. For mother’s level of education, the results show that there is no significant association with changes in access to safe water (chi-sq.=7.40, p-value>0.05), but the evidence for these results is very weak (Cramer’s V coefficient=0.07). For main constraints to access, the results show that there is moderately strong evidence for a significant association with changes in access to safe water (p-value=0.00, Cramer’s V=0.18). Mood’s Median test was used to test differences in median distance across the levels of changes in access to safe water since this continuous variable is not normally distributed. The results show that there are significant median distance differences across outcome levels (chi-sq.=110.41, p-value<0.05).

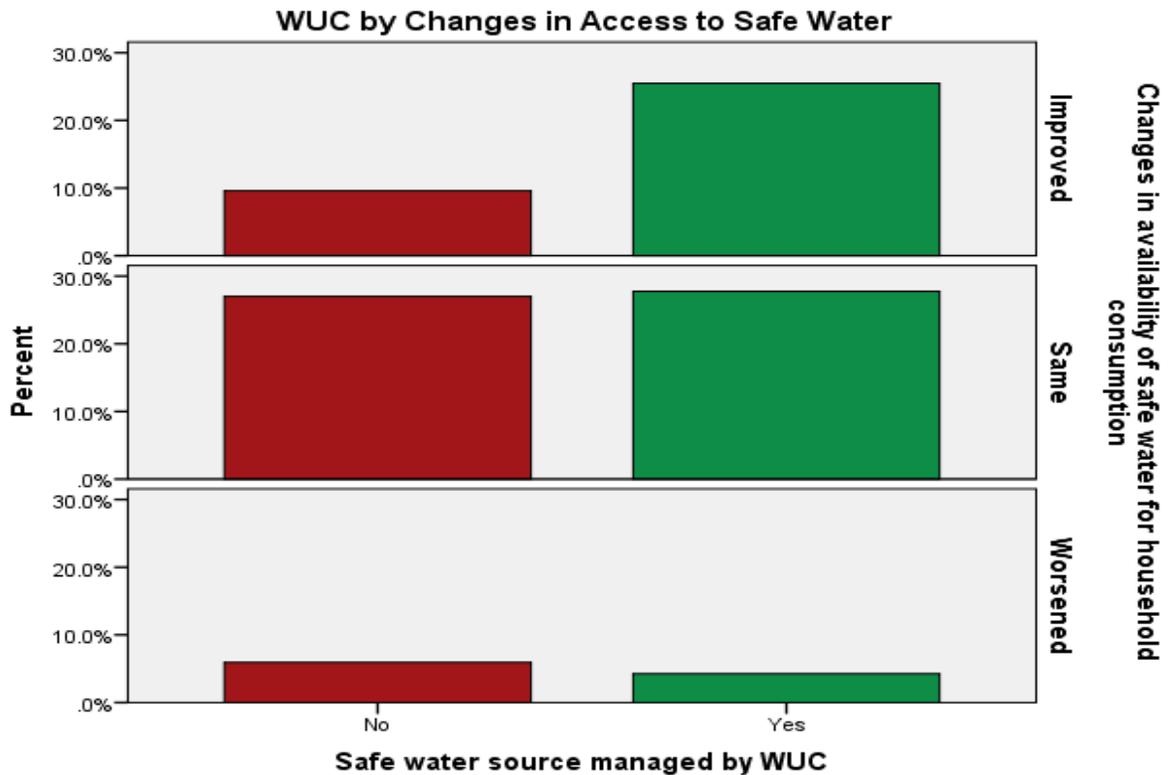
**Table 2- Bivariate Analysis: Changes in Access to Safe Water**

<b>Variable</b>	<b>Chi-sq.</b>	<b>P-value</b>	<b>Coefficient</b>	
<b>Water source managed by WUCs</b>	108.46	0.00	0.23	
<b>Purpose of water Fees</b>	7.66	0.02	0.11	
<b>Main constraints to access</b>	126.48	0.00	0.18	
<b>Mother's level of education</b>	7.40	0.29	0.07	
<b>Distance</b>	<b>Median</b>	<b>Chi-sq.</b>	<b>df</b>	<b>p-value</b>
	0.50	110.41	2	0.00

*Grouping Variable: Changes in availability of safe water for household consumption*

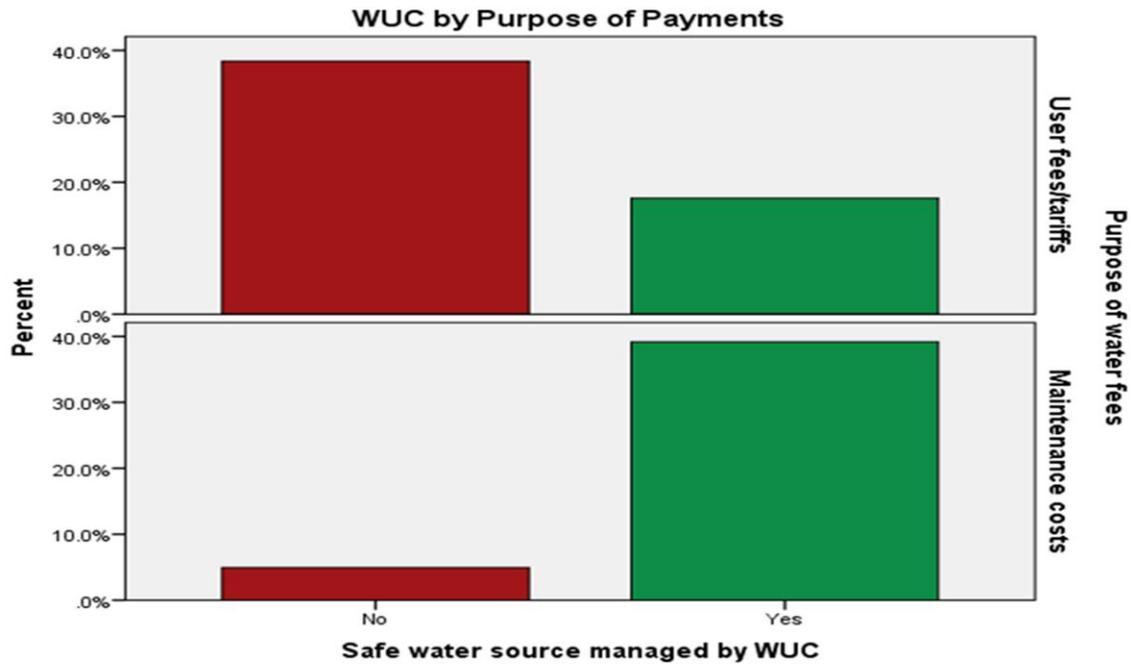
An essential aspect of the functionality of WUCs is their ability to collect fees that can be used to maintain the safe water sources. *Figure 1* shows that households serviced by a WUC had a higher proportion of improvement and a slightly lower proportion of deterioration in safe water access compared to those without a WUC. However, looking at the deterioration category in *Figure 1*, the difference in proportion between households with a WUC and those without is approximately 5 percent. While there is a difference, it is quite small, therefore raising doubts about the added advantage of having a WUCs as a factor in mitigating deterioration of access to safe water.

*Figure 1- WUCs and Changes in Access to Safe Water*



*Figure 2* shows that households with a WUC have a higher proportion of maintenance fees being collected compared to households without a WUC. These results show that the presence of WUCs could facilitate the collection of maintenance fees, which can in turn ensure that the water sources are maintained. *Figure 2* also shows that some households in communities without a WUC are paying maintenance costs, meaning that some communities are still able to collect maintenance fees for the water source even without a WUC (though this proportion is very small).

**Figure 2- WUCs and Purpose of Payments**



The bivariate results have shown that while there is moderately strong evidence of an association between WUCs and changes in access to safe water, the impact of WUCs in mitigating deterioration in access to safe water could be limited. The regression model below will expand on this point.

**Regression Model**

Table 3 shows the results of the regression analysis for WUCs, distance, and mother’s level of education. Both WUCs and distance are statistically significant (p-value <0.05, 95% CI from 0.42 to 1.03, and 0.41 to 0.75, respectively). Since ordinal logistic regression in SPSS does not provide the OR directly, it was calculated in excel by computing the exponential of the parameter estimates (B coefficients) that SPSS provides (Strand et al., 2011). Given that WUC=1 (yes) is the constant, the negative exponential of WUC=0 was used to calculate its OR (Strand et al., 2011). The results show that households with a WUC are 0.48 times (52 percent) less likely to report a deterioration in access to safe water, while those without a WUC are 2.07 (107 percent) more likely to report a deterioration. Furthermore, each unit increase in distance increases the odds of reporting a deterioration in access to safe water by a factor of 1.79,

meaning that as distance increases by one unit (1kms), the odds of reporting a deterioration in access to safe water increases by 79 percent. The mother's level of education is not a significant predictor of the outcome in this model, meaning that this individual level social capital variable does not have an impact on changes in access to safe water.

*Table 3-Modeling the Impact of WUCs*

		Regression Model							
		Estimate	S.E	Wald	df	p-value	95% CI		OR
							Lower	Upper	
<b>Threshold</b>	Change in access= 0	-0.26	0.37	0.52	1	0.47	-0.98	0.45	
	Change in access= 1	2.84	0.39	53.53	1	0.00	2.08	3.60	
	Distance	0.58	0.09	45.21	1	0.00	0.41	0.75	1.79
	WUC=0	0.73	0.15	22.13	1	0.00	0.42	1.03	2.07
	WUC=1	0a	.	.	0	.	.	.	0.48
<b>Location</b>	Mother's Ed.=0	-0.35	0.37	0.90	1	0.34	-1.07	0.37	
	Mother's Ed.=1	-0.20	0.38	0.26	1	0.61	-0.95	0.55	
	Mother's Ed.=2	-0.34	0.39	0.72	1	0.40	-1.11	0.44	
	Mother's Ed.=3	0a	.	.	0	.	.	.	
		<b>Model Fitting Information</b>				<b>Goodness-of-Fit</b>			
<b>Model</b>	<b>-2 Log Likelihood</b>	<b>Chi-Sq.</b>	<b>df</b>	<b>p-value</b>		<b>Chi-Sq.</b>	<b>df</b>	<b>p-value</b>	
<b>Intercept Only</b>	595.72				<b>Pearson</b>	290.70	291.00	0.49	
<b>Final</b>	519.84	75.87	5.00	0.00	<b>Deviance</b>	296.89	291.00	0.39	
		<b>Test of Parallel Lines</b>				<b>Pseudo R-Square</b>			
<b>Model</b>	<b>-2 Log Likelihood</b>	<b>Chi-Sq.</b>	<b>df</b>	<b>p-value</b>					
<b>Ho</b>	519.84					Cox and Snell		0.10	
<b>General</b>	513.57	6.28	5.00	0.28		Nagelkerke		0.12	
						McFadden		0.06	

*Link function: Logit*

While the confidence interval contains a one for WUCs in the above model, which is a reason for caution when interpreting the significance of the results, the model overall is still the best model for this paper. First, the goodness of fit and test of parallel lines show that the model

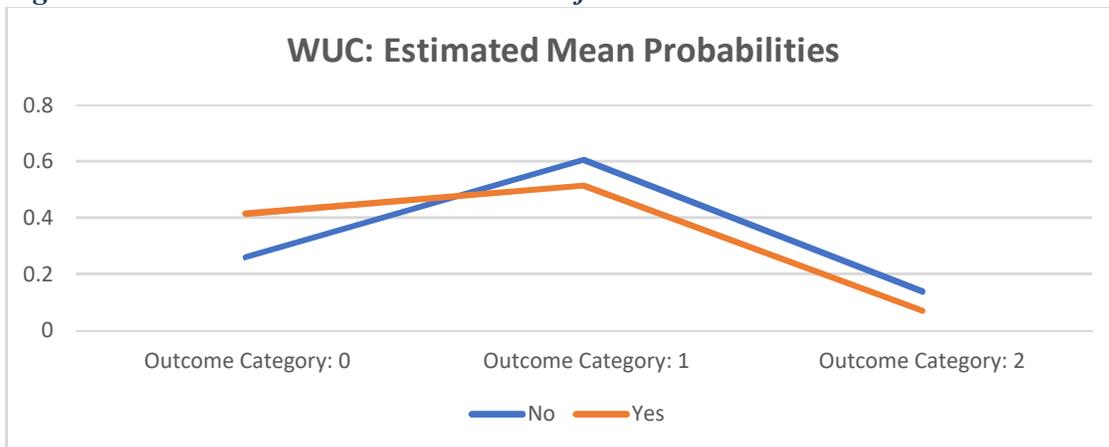
is a good fit for the data, and that the proportional odds assumption has been satisfied ( $p$ -value  $>0.05$ ). Second, the model fitting information, which compares a baseline model (intercept only in *Table 3*) without any independent variables to the model presented here (final model in *Table 3*), gives information regarding how much better the final model is at predicting the outcome compared to the baseline model. The significant chi-square statistic of this final model ( $p < 0.05$ ) indicates that it gives a significant improvement over the baseline model. This means that the model gives a better prediction than if it is based on the marginal probabilities of the outcome categories (Strand et al., 2011). Finally, the Nagelkerke R-squared shows that the final model is accounting for 12 percent of the variation in the data that is not due to chance.

### Estimated Probabilities

When running the regression analysis, estimated probabilities were requested, and SPSS produced them as new variables for each level of the outcome. These are important because they can be used to explore the predicted probabilities in relation to the explanatory variables (Strand et al., 2011). In *Figure 3* below, the estimated probability of being at each level of the outcome was produced by comparing the mean probabilities for each category of WUCs.

The estimated probability of reporting a deterioration when there is a WUC is just below 10 percent, and the probability without a WUC is just above 10 percent. Clearly, the difference is not very large, meaning the added advantage of having a WUC does not change the probability of reporting a deterioration in a major way. In fact, given these probabilities, and the regression results, the influence of WUCs seems to be limited.

**Figure 3- Estimated Outcome Probabilities for WUCs**



## Testing Collinearity

To test for collinearity (the predictability of one independent variable given another independent variable), chi-square tests with Lambda proportional reduction of errors (PRE) was used for the categorical predictors, and the Spearman correlation test was used to test for correlations between distance and the categorical predictors. Lambda is useful in that it gives a measure of predictability between two variables that is between 0 to 1, like correlation, but for nominal variables. The symmetric Lambda values and the Spearman test results for all the predictor variables were assessed.

Because of the Lambda results, purpose of water fees was left out of the regression analysis because of the following reasons: (a) the value of predictability between WUC and purpose of payments was evidently very strong (0.49), and moderately strong predictability was observed for main constraints (0.23), and (b) the association with mother's level of education could not be computed because the standard error was zero. For the Spearman test, distance had significant correlations with all the variables except the mother's level of education.

Furthermore, the correlation of distance with purpose of payments is moderately strong, which is another reason for leaving this variable out of the regression analysis. The correlation with WUCs is very weak (0.05), and with main constraints weakly moderate strength (0.17) and so the inclusion of all three in the model is not expected to have had a major impact on the results.

## Discussion

The results of this paper support the hypothesis, as stated on page 8, in that households in communities that have WUCs are 52 percent less likely to report a deterioration in access to safe water. However, regarding the research question (on page 8 as well), social capital, in the form of WUCs, does not have a major influence on household sustainable access to safe water. The results show that the influence of WUCs on sustainable access to safe water is limited since the model presented shows that it only explains 12 percent of the variation in data. Furthermore, the difference between those with and those without a WUC for the predicted probability of deterioration is quite negligible. Therefore, while there is some evidence that a community-based management (CBM) approach to water source maintenance, as advocated for in the 2015 UNSDGs, can help in the achievement of sustainable development, this approach is not good

enough in the case of Uganda's WUCs. There are several reasons why CBM has failed to work in Uganda, and these will be discussed through out this section.

### **A Weak State and Lack of Local Ownership**

There are several reasons why the switch from a supply-driven to a demand driven approach for water provision, which is the backbone of CBM in Uganda's WUCs, failed. First, Uganda was very unstable politically from the mid 70s to the late 80s (Kibanja et al., 2012). This political instability could have led to the failure of the supply driven approach since the government was very weak at the time of its implementation. The supply-driven approach required a strong state to oversee the implementation of safe water access projects, but this state was inexistent in Uganda at the time. Furthermore, the demand-driven approach has been shown to not be demand driven at all in the Ugandan case. NGOs, under pressure to meet development targets were the driving force behind the demand for safe water sources in many cases (van den Broek and Brown, 2015).

While the demand-driven approach is said to have increased access to safe water by encouraging community participation, the numbers mask an underlying problem. Naiga et al. (2015)' s study found that more than half of water sources are currently non-functional, even though official documents list them as functional. The study further states that the operation and maintenance of drinking water infrastructure still faces major challenges since it depends on local collective action. Some of the reasons cited for a lack of collective action to maintain water sources include a policy shift that was not accompanied by consistent regulation, adequate funding, and monitoring. For example, while it was a pre-condition for each community to elect a WUC and a water source caretaker before installation of a water source, some had neither a source caretaker nor a WUC in place, and others were inactive WUCs (ibid).

The results of this paper show that almost half of the households surveyed (46.7) do not have a WUC. Therefore, even though decentralization initially led to improved access, operation and management (O&M) still poses a great challenge, accounting for over 50 percent of non-functionality of water sources in rural areas (Nsubuga et al., 2014), which means that more households lack continued access to safe water. In this paper, approximately 10 percent of households reported a deterioration in access to safe water.

Secondly, over 80 percent of the Ugandan population lives in rural areas, and 76 percent of the rural population gets its safe water from a communal water point (Naiga et al., 2015).

Therefore, the results of this paper, which show that about 10 percent of households reported a deterioration in access to safe water, raise concerns not only regarding sustainability of current access and management methods, but also of safe water availability for many households after 2025. The sentiment on the ground in Uganda is that the government or NGOs should provide funds to maintain the infrastructure since they provide 90 percent of the construction funds (van den Broek and Brown, 2015, Naiga et al., 2015, Golooba-Mutebi, 2012). This belief is said to be an impediment to the achievement and sustainability of collective action to ensure that water sources are maintained (Golooba-Mutebi, 2012). However, the decision to shift from a supply-driven to a demand-driven approach to water provision was a top-down process introduced by international development organizations. Therefore, while some WUCs can collect maintenance fees, many households believe that the burden of operation and management of the safe water sources should fall on either the government or the NGOs that paid for their construction. Gasteyer and Araj (2009) support this belief, and argue that in contrast to existing literature, community water management (CWM) is dependant on a strong state that can provide regulatory, financial, and technical assistance to communities to assist in managing water and assuring that it meets basic health standards.

In Uganda, the government's capacity to provide regulatory, financial, and technical assistance is highly limited. Independent studies have found that relevant officials often do not receive adequate and timely funding for planning and implementation of the demand-driven approach. For example, a qualitative study by Naiga et al. (2015) quotes officials claiming that the untimely release of funds coupled with the requirement to return unused funds at the end of the fiscal year forced them to install water infrastructure even when certain conditions such as presence of WUCs were absent. Therefore, even though on paper there seems to have been a smooth process of receiving community requests for water and subsequent construction of water sources by the districts in response, the reality is that in many instances there was little community involvement. Because of this limited or lack of community involvement, water users in Uganda still tend to believe that government authorities, not users, are responsible for providing and maintaining safe water sources. The lack of ownership of the infrastructure could be an impediment to the achievement and sustainability of collective action to ensure that safe water sources are maintained (Golooba-Mutebi, 2012). This is also evidenced in the results of

this paper, which show that only 44 percent of the water fees levied are for maintenance purposes.

The inability of WUCs to collect fees negatively impacts O&M, which is supposed to ensure that water sources are kept functional and safe. O&M is either weak or nonexistent, leaving water sources at the risk of contamination and subsequent abandonment. Poor water source catchment management has also been cited as an important contributor to the decline in availability of safe water. When sources are not maintained, they are abandoned, thus leaving communities without access to safe water (Nsubuga et al., 2014, Naiga et al., 2015, Golooba-Mutebi, 2012). Channels of water contamination can easily be mitigated through community involvement in protecting and maintaining the water catchment areas.

### **Mother's Education**

As discussed earlier, various studies show that the mother's education can be significantly associated with developmental outcomes (Zurovac et al., 2006, Choudhury, 2015). Baguma et al. (2013) also found that women performed most of the water related activities on behalf of the family unit, and concluded that to achieve sustainable results, emphasis should be put on female-oriented activities, such as trainings in the women's roles in water management. Surprisingly, however, the mother's level of education, which is an individual-level social capital measure, is not significantly associated with changes to access to safe water, though the strength of the evidence for the results is very weak.

The lack of conclusive results could be because most mothers had very low levels of education to begin with (no education is 43 percent, and primary education is 36 percent). Another reason for the inconclusiveness of the results in this paper could be the way data were managed. Future analysis of this phenomenon could explore the differences between mothers who have completed at least primary level education with those who have no education or never completed at least primary level to see if there are differences as this division would be more absolute.

### **Study Limitations**

This study has analyzed the role of community involvement in water resource management. While the data and analysis contribute to our understanding of social capital and

public health, the results need to be viewed and used with caution for several reasons. First, the cross-sectional nature of the data makes the results susceptible to endogeneity as factors such as socio-economic status and ethnic composition of the community, which could affect functionality of the WUCs, were not controlled for in this study.

Second, it is not clear in the data whether the households that indicated that the water sources were managed by a WUC were referring to both functional and non-functional WUCs or only functional ones. This lack of clarity may have affected the analysis in that non-functional WUCs may have no impact on the levels of the outcome, thus, the low variance in the data explained by WUCs.

Thirdly, the intermediate level of the outcome can be difficult to interpret; results for households that reported no changes on access to safe water are impossible to analyse because there is no indication of the initial level of access (good or poor). This lack of details may have weakened the results of this paper, and could be a confounding factor in the results reported.

## **Conclusions**

The results of this study are consistent with what other researchers have reported, including the fact that the demand-driven approach, represented by the WUCs, improves access to safe water by facilitating the construction of new infrastructure. However, the results also raise some doubt about the ability of WUCs to maintain safe water sources since they seem to have a relatively small impact on mitigating the deterioration in access to safe water. Community involvement in local water management has been shown to be a weak contributor to sustainability of safe water access in the context of Uganda. The demand-driven approach is only useful to extending, not maintaining, access to safe water sources. The government and NGOs need to play a more prominent role in helping communities maintain their water sources, especially since they pay almost all the start-up costs. More research could explore more innovative ways to help communities, such as the use of copayments between governments/NGOs and the local community, for the specific purpose of maintaining the water sources once constructed instead of maintaining a *laissez-faire* attitude.

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## Appendix I

### Figure 4

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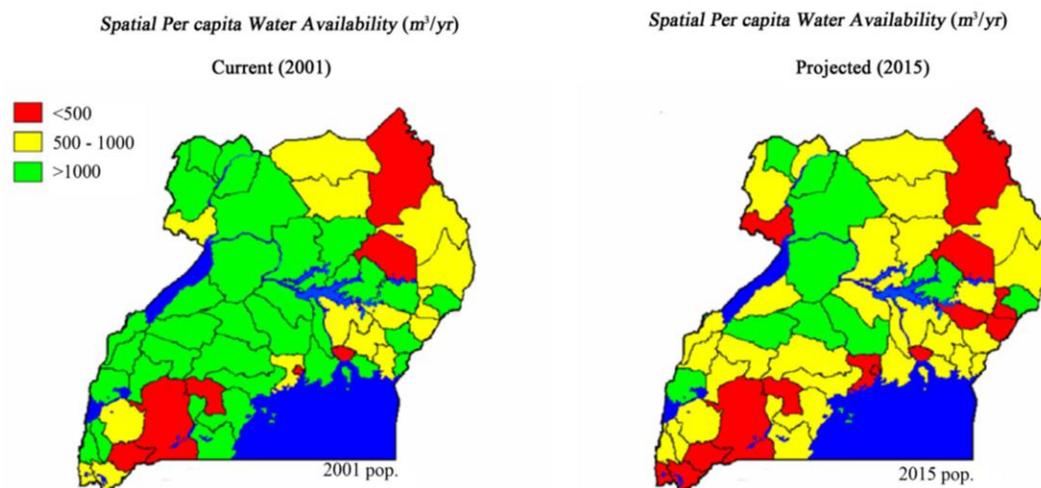


Figure 3. Spatial per capita surface water distributions (m<sup>3</sup>/yr). Source: WRM sub-sector Reform study report, 2004.

## Appendix II

### Popular Science Summary

Did you know that globally, approximately 1.8 billion people use a drinking-water source contaminated with faeces? Or that, despite all the aid that is been given over the last 60 years towards the noble goal of ensuring everyone has access to clean water, 663 million people worldwide still lack access to this basic human need? Not having access to clean water or using contaminated water means that many children die before their fifth birthday from easily preventable diseases such as diarrheal. To prevent this number from growing, we need to focus some resources in ensuring that access to safe water is maintained. The results of this paper show that ten percent of the Ugandan households reported a deterioration in access to safe water. That means ten percent more babies could be dying from a preventable disease. That is why we need to find innovative ways to address the problem.

The United Nations, which is like a global government that all countries can participate in, signed an agreement in 2015 with one of the goals being ensuring not only availability, but also sustainability of access to safe water by 2030. The world government thinks that this can be

done if communities participate and work together. BUT, there have been studies, including this one, pointing to the weakness of community participation in ensuring access to safe water. Communities and governments must work together, instead of separately, to make sure those who have clean water continue to have it. That way, the noble goal of ensuring everyone has access to clean water can be reached sooner rather than later.