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Effect of Household Water-User Preference on the Sustainable Supply of Safe Water in Obunga Slums of Kisumu Municipality, Kenya

Elisha Ongere Dickson
Kenyatta University, Nairobi, Kenya
Dr. Samuel C. J. Otor
Kenyatta University, Nairobi, Kenya
Dr. Augustine Afullo
Maasai Mara University, Kenya

Abstract:
Access, availability, and quality of water must be in sustainable supply for humans to become water secure. Sustainable supply of water is ensured through efficient use of water on one hand, and integrated approach to water management on the other hand. The informal settlements, where majority of the urban population lives, are not covered by water connections and prudent water-user preference is necessary to ensure sustainable supply of water. The purpose of this study was to examine the effect of water-user preference on the sustainable supply of safe water in Obunga slums, and specific objectives were to assess the household water-user preference, and to determine the effect of household water-user preference of the sustainable supply of water. Ex post facto research design was adopted for the study on a population of 2,507 households divided into four administrative units, Amin's table and stratified sampling technique were used to select 331 household for questionnaire administration. Test retest and expert consultations were used to ensure reliability and validity respectively. Questionnaire return rate yielded 254 respondents representing 76.7%. It was found that households in Obunga slums have poor water-user preference, and most households have moderate sustainable supply of water. The hypothesis that household water-user preference in the slums is dependent on the sustainable supply of water was therefore accepted. It was concluded that increased water conservation and curtailment behavior ensures water security to households.

Keywords: *Water-user preference, households, sustainable supply, Water resource management*

1. Introduction

Supply of safe water is a critical issue globally in the face of population growth, change in land use, urbanization, poor management of water supply network and resources, and marginalization of regions occupied by less privileged communities. UNICEF and WHO (2008) estimate that close to 1.3 billion living in urban areas in the developing World remain untapped. The utilities' lack of commitment to provide water to areas occupied by less privileged communities are fuelled by concerns including the perceived lack of willingness and ability of poor people to pay for water services, concerns over the safety of expensive infrastructure, problems of insecure or disputed land ownership, and the perception of slums as a "water engineer's nightmare" (Franceys and Gerlach, 2008)

The recently published WHO/UNICEF progress report (2010) noted that significant proportion of the world population (87%) has got access to safe drinking water, a progress of 10% within the last two decades. In spite of this marked progress, about 884 million people worldwide, out of which Sub Saharan Africa accounts for 37% as people still using drinking water from unsafe supply spots (WHO/UNICEF, 2010). Concerning countries safe drinking water access worldwide, it was estimated that a little over 10 countries do have less than 50% access (World water, 2010).

Regarding the case of Africa, the situation is not that much promising as 340 million Africans are still in need of access to and sustainable supply of safe drinking water and the continent is lagging behind the attainment of the Millennium Development Goal (UN world water, 2009). According to WHO/UNICEF (2010) update, the proportion of the African population who get accessed to safe drinking water accounts for only 60%, which is about 11% increase compared to the situation in 1990. The challenge is even worse for those in ASALs and residents of informal settlements (Afullo et al., 2014 and Afullo, 2015).

In areas that are most affected by frequent shortages of water, a key platform for ensuring household water security in the face of inadequate water infrastructure is through encouraging the communities to use less water and conserve the little water that is available (Spinks, Fielding, Russell, Mankad and Price, 2011)

Increased water-use efficiency ensures that water resources are used in a reasonable, effective and sustainable manner. Greater attention must be given to the prevention of pollution and other forms of water quality degradation (Njagi et al, 2013). According to Bates, *et al*., (2008) and Maoulidi (2012) current water use is often not sustainable, and new technologies and management methods are required which are underpinned by science. For example, only about 7% of the water is used for cooking and drinking, while one third of the water is flushed down the toilet.

Spinks *et al* (2011) outlines specific curtailment (or ways of using water wisely and sustainably) as (i) Collection of rainwater to use on garden; (ii) dishwasher to be run only when full (iii) shorter showers; (iv) use of half flush or not to flush toilet every time; (v) washing cars with less water; (use minimal water in the kitchen; (vi) collection and use of grey water on gardens, etc.; (turning off of taps when brushing teeth; and (vii) checking and fixing of leaking taps.

Similarly, efficiency in conservation behaviour was detailed by Spinks *et al* (2011) as (i) the use of low-flow taps and / or shower heads on all fittings (ii) pool cover; (iii) use of hose with trigger or a timed sprinkler; (iv) water-wise plants or gardens; (v) construction and use of composting toilets; (vi) grey water systems; (vii) rain water harvesting and storage tanks plumbed into the house; and (viii) rainwater tank not plumbed into the house.

Water use refers to the amount of water taken for a given task or for the production of a given quantity of some product or crop (Chenoweth, 2008). It also refers to water taken in for agriculture, industry, energy production and households, including in-stream take-ups such as fishing, recreation, transportation and waste disposal (Hoekstra, 2006; and Afullo et al, 2014). According to Hoekstra (2006), water can be used renewably and non-renewably. In psychology, preferences could be conceived as an individual's attitude towards a set of objects, typically reflected in an explicit decision-making process (Lichtenstein and Slovic, 2006). In this study, preference refers to a tendency of household water-users to choose one use of water in relation to another, or to others, or to allocation of more water for other uses as opposed to others.

Blaustein (2010) observes that despite considerable progress in recent years, water scarcity still persists in Kisumu town, and water-borne diseases such as cholera, dysentery and typhoid still contribute to numerous deaths every year. According to Afullo and Danga (2013); and Afullo et al, (2014), Kisumu's water production is not keeping pace with its rapid population growth despite the fact that the town lies next to Lake Victoria (one of the largest fresh water bodies in the World), while the existing infrastructure is operating at between 85% and 93% of its design capacity, making the town to be a water scarce area. Afullo and Danga (ibid) and Blaustein (2010) concur that the greatest challenges lie in the peri-urban areas and informal settlements, where water sources are often unreliable and sanitation systems are insufficient. The pollution of water resources are widespread (Ndubi et al, 2015), seriously compromising water security across most parts of Kenya.

According to Blaustein (2010), over 60% of households in Kisumu do not have access to fresh water, and about 53% of the households lack adequate water supplies. About 62.3% of the water sources are not sustainable, and the quality of water is generally poor and not suitable for household use (Afullo and Danga, 2013). But as UN (2007), UNESCO (2006b), and several other authors indicate, water security is the responsibility of both the user and the provider. In view of the fact that Kisumu Municipality is a water scarce region, (Wagah, *et al.* 2010) and it is the water - users that ought to be diligent in using water. By 2005, KIWASCO environmental audit indicated that water supply and quality remained a challenge (Afullo, 2005).

The status of water use by households in Kisumu Municipality has not been investigated despite the evidence of high water insecurity in the municipality, and therefore this study sought to investigate the influence of household water-user preference on water security in Obunga slums of Kisumu Municipality.

2. Literature Review

Various studies conducted pertaining to water supply services have produced definitions concerning sustainability in the context of water supply projects. Most of these definitions capitalize on financing of regular operation and maintenance costs by users, minimal external assistance in the long term, and continued flow of benefits over a long period (Tadesse et al, 2013). Sustainability is about whether or not water supply services continue to provide safe water to particular residents' overtime. The achievement of sustainability engrosses the realization of enduring "beneficial" changes in water services.

In this case, the issue of sustainability is considered further than limiting itself on technical functionality debate; the expression "beneficial" highlights the outcome on the lives of people and it indicates to services other than technology (Jansz, 2011). Over years, several conceptual frameworks have been produced to better understand the essence of rural water supply sustainability. Among those developed conceptualization frameworks, the one that has been shared by many researchers has five key dimensions (Ibid): institutional (organizational), social, environmental, technical, and financial. It is well noted that the success of lasting sustainable water supply services is dependent on the interaction of a combination of factors that give due emphasis for community participation, external collaboration and technical support in order to ensure operation and maintenance of the system (Tadesse *et al*, 2013).

In Kenya, the provisions in the Water Act of 2002 (Republic of Kenya, 2002) created Water Resources Management Authority (WRMA) whose mission is to manage, regulate and conserve all water resources in an effective and efficient manner by

involving the stakeholders, guaranteeing sustained access to water and equitable allocation of water while ensuring environmental sustainability.

The Water Act (Republic of Kenya, 2002) further introduced eight Water Services Boards (WSBs) to be responsible for the management of efficient and economical provision of water and sewerage services, and Water Services Providers (WSPs) to act as agents of the Water Services Boards (WSBs) in the actual provision of water and sewerage services, among other technical institutions. The Lake Victoria South Water Service Board is responsible for the management and efficient distribution of water in Kisumu County, and Kisumu Water and Sewerage Company (KIWASCO) acts as an agent of WSB responsible for the actual provision of water and sewerage services in Kisumu (Hakijamii Trust, 2012).

The integrated water resource management approach has become increasingly widespread in the World over the past two decades with considerable success, whereby the need to meet both human and ecosystem needs (while recognizing their interdependencies) is paramount (Cook and Bakker, 2012). Haysom (2009) explored the reasons behind non-functionality of water distribution points in central Tanzania using a purposive survey covering 38 villages in six different districts in Dodoma and Singida regions and found that lack of financial management skills and non engagement of the community correlates positively with the collapse of water supply systems.

However, a water shortage have been reported in Kisumu since the 1980s (KIWASCO, 2007) despite prudent integrated management style that has been adopted by the Ministry of Water. By 2007, only 36% of the city's population had service coverage (Schwartz and Sanga, 2010). As a result, the majority of the municipality's population lacks a sufficient quantity of water for uses such as cooking and cleaning (Wagah *et al*., 2010).

Most studies (KIWASCO, 2007; Cook and Bakker, 2012; Wagah et al 2010) have concentrated their efforts on measuring the effectiveness of water utilities in ensuring that sustainable supply of safe water reaches end consumers, the way consumers prefer to use water has been given minimal focus although this can also negatively affect sustainable supply of water (Spings *et al*, 2011). This study focused on the effect of water user preference on the sustainable supply of safe water in Obunga slums in Kisumu Municipality.

3. Methodology

3.1. Study Area

The study was conducted in Obunga slums in Kisumu Municipality between the months of March and July, 2012. Administratively the slums are in Kanyakwar Sub-location, in East Kisumu Location, in Winam Division of Kisumu Central Constituency, Kisumu West sub-county, in Kisumu County. The population of Kisumu municipality by Kenya national population and Household census of 2009 was 473,649. This is when Obunga slums had population of 8211. The Rver Obunga originates from a swamp bordering the slums to the West and North. Obunga Sega sega and Obunga Kasarani borders this swamp and stream. The stream does not have high volume of water to be used as a reliable source of water by the residents of the slums. Its water volume is low and polluted by activities of small scale farming and sewage dumping. The residents don't use it for drinking and cooking because it is highly polluted by effluents from raw sewage dumped on it directly. Figure 1 shows the map of Kenya, indicating the location of Kisumu.

Figure 1: Map of Kenya showing location of Kisumu town
Source: The Researcher data, 2015

The housings in Obunga slums are characterized by congested dwellings like those shown on figure 1 above. These houses lack water pipings. They depend on stand pipes which are a few meters away or in the same compounds, for water. The residents buy water from sellers at the standpipes or from water vendors who bring water in 20 litres jerricans to the house. The residents buy water from standpipes for drinking and cooking, but use water from shallow wells for washing, toilet and gardening. The shallow wells in the slums are within reach and the residents get much water as they need without buying. This has encouraged much use of water from shallow wells for washing, toilet purposes and gardening. They use tap water and water from the shallow wells according to their preferences.

The numbers of shallow wells, according to Obunga Watsan office data, are 22 in the entire area. There is little commercial activities in the area, save for small scale fish drying businesses and green grocery. The area lies about 2.5 km from the Central Business District (CBD) of Kisumu municipality. Figure 2 is the map of Kisumu Municipality showing the location of Obunga slums.

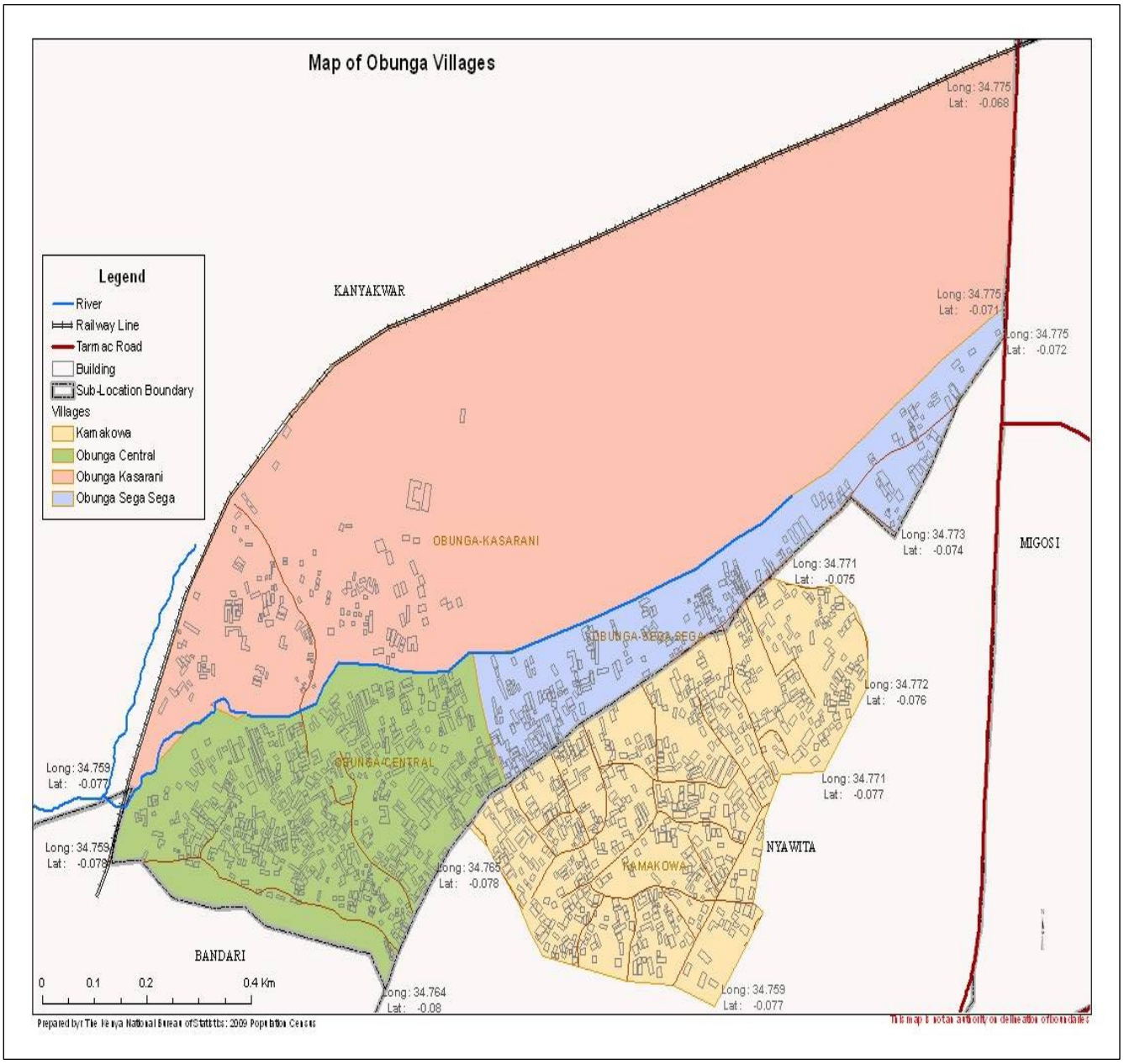

Figure 2: Map of Obunga slums in Kisumu municipality.
Source: KNBS data, 2009

3.2. Study Population, Sampling Procedure and Data Collection

All the people under consideration in any field of investigation constitute targeted population (Kombo, 2006). The slums have a total population of 8,211 comprising 4,275 males and 3,936 females in 2,507 households; the population density of the area is 4,561 persons per km^2. The area of study covers 1.8 Km^2. The slums have one of the highest population densities in Kisumu municipality (KNBS and PC, 2009). The target population for this study comprised the 2,507 households in the 4 administrative units, being: Obunga Central, Obunga Kamakowa, Obunga Segasega, and Obunga Kasarani,

The sample size comprised 331 households in Obunga slums. The sample was determined according to Amin's (2005) table of samples, and was distributed among the 4 administrative units in the slums. Amin (2005) recommends a sample of 331 for a population of 2,507, at 0.05 level of confidence and 5.0% margin of error. These were the same conditions which the researcher used on the study. For each administrative unit, the sub-sample size was determined as: *Sub-sample size = (sub-population size/total population) required sample size*.

ss = (sp/tp) Sample Size;

Where ss denotes sub sample size; sp is sub population size; tp is total population.

Therefore, the sample size of households in each administrative unit was determined as follows:

Administrative Unit	Determinant	Sample Size
Obunga Central	(766/2507) x 331	101
Obunga Kamakowa	(645/2507) x 331	85
Obunga Kasarani	(573/2507) x 331	76
Obunga Sega sega	(523/2507) x 331	69

Table 1: Determination of Sample size

Simple random sampling method was used to select the households to be used in the study, while purposive sampling technique used to select key informants who were interviewed in the study.
Questionnaires and interview schedules were used for data collection, whereby test retest method was used to ensure instrument validity. Similarly, reliability and validity of the instruments were obtained through checking for representativeness of data, checking for bias due to observer bias or the influence of the researcher on the research situation, cross-check data with evidence from other independent sources and comparing and contrasting the data during the stage of qualitative investigation on the conflicts. Through pilot testing, the instruments were reorganized and some parts deleted to enable the researcher to get a working instrument. The final instrument obtained was the one used to collect the required data.

3.3. Data Analysis and Results Presentation
Qualitative data obtained from personal interviews and open-ended questions were analyzed qualitatively through content analysis and organized into themes and patterns corresponding to the research questions. This helped the researcher to detect and establish various categories in the data which are distinct from each other.
Quantitative data such as statistical information on biographical backgrounds of the respondents, household water-user preference and sustainable supply of was analysed by the help of statistical packages for social sciences (SPSS). SPSS package is able to handle a large amount of data and given its wide spectrum in the array of statistical procedure which are purposefully designed for social sciences; it was deemed efficient for the task. Descriptive statistics such as frequency distribution and percentages were run on all the quantitative data.
Chi-square was used to compare the differences between water securities of households as a result of different household water-user preferences. In this study, the independent variable (household water-user preference) is categorical. Categorical variables are best analyzed through Chi-square (Amin, 2005; Oso and Onen, 2008). It was therefore suitable to analyze these data using Chi-square, which is a technique that compares group differences of subjects that are exposed to different treatments. Treatment in this study was household water-user preferences in each household. The study classified household water-user preference for each household as good, moderate and poor, and then compared the differences between the elements of sustainable supply of water, categorized as water conservation and curtailment behavior.

4. Results and Discussions

4.1. Results
In order for the researcher to establish the actual effect of household water-user preference on sustainable supply of water, the household water user preference was first analysed.

4.1.1. Household Water-User Preference
Household water-user preference was assessed based on the UN- WWAP (2009) ratios on the water that was used on; personal washing, gardens, laundry, toilets, car washing, dishes and cooking, and drinking. The respondents in each household were asked to indicate how much water they use on each of these aspects per 100 litres or five 20 litres jerricans of water. The ratios were then compared to the UN WWAP (2009) Model, in line with the scores indicated in Table 1. The results indicated in Table 2 were obtained.

Levels of Household water-user Preference	N	Percent – N
Poor	114	44.9
Moderate	66	26.0
Good	74	29.1
Total	254	100.0

Table 2: Levels of household water-user preference
Note. N= number of households

This table shows that 44.9% of the households have poor household water-user preference while 29.1% have good household water-user preference. It can be seen that most households do not use water in the good proportions as recommended by the UN-WWAP (2009).

4.1.2. Effect of Water-User Preference on Sustainable Supply of Water

Sustainable supply of water was measured through recharge rates (how many more 20 litres jerricans they buy in a day), discharge rates (how many 20 litres jerricans they use in a day), and storage systems (how many 20 litres jerricans and other means of storing water) in the households in the slums. Respondents were asked to respond to issues intended to measure sustainable supply of water and the responses were then assessed, scored and rated such that households that scored between 6 and 12 were rated poor and coded 1, those that scored between 13 and 19 were rated 'moderate' and coded 2, while those that scored between 20 and 26 were rated 'good' and coded 3, as highlighted in Table 1. The sustainable supply of water was compared against household water-user preference for each household to determine the actual number of households in the slums that have poor, moderate and good sustainable supply of water, against the poor, moderate and good household water-user preference. The results are summarized in Table 3.

Levels of Sustainable supply of water and Households Distribution		**Household water-user preference**			
		Poor	Moderate	Good	Total
Poor	Frequency	34	22	20	76
	Percent	13.4	8.7	8.7	30.1
Moderate	Frequency	40	22	34	96
	Percent	15.7	8.7	13.4	37.0
Good	Frequency	36	27	19	82
	Percent	13.8	8.3	9.5	32.9
Total	Frequency	110	71	73	254
	Percent	43.3	28	28.7	100.0

Table 3: Household water-user preference and sustainable Supply of water in Obunga slums
Source: (Field Work 2015)

As is indicated in the table above, most (37.0%) of households in the slums have 'moderate' sustainable supply of water while 32.9% have 'good' sustainable supply of water; and 30.1% have 'poor' sustainable supply of water. Further, the table shows that most (15.7%) with 'moderate' sustainable supply of water have 'poor' household water-user preference and that only 8.3% of the households with 'good' sustainable supply of water have 'moderate' household water-user preference. But a significant proportion of 13.4% of households with 'poor' sustainable supply of water also have 'poor' household water-user preference.
The data in Table 3 were further tested using a Chi-square test to determine if there were significant differences in the frequencies between the categories indicated in the table; and to test the hypothesis that household water-user preference in the slums is dependent on sustainable use of water. The results of the chi- square test are summarized in Table 4.

Variable	**N**	**Df**	χ^2_c	χ^2_o	**A**	**Decision**
Household water-user preference and sustainable supply of water	254	4	9.488	3.593	0.464	Accept Ha

Table 4: Chi-square analysis of household water-user preference and sustainable supply of water

The information in the table indicates that there is insignificant difference in household water-user preference based on the sustainable supply of water. From the table, $\chi^2_o = 3.593 < \chi^2_{c\,(4,\ .05)} = 9.488$, which indicates that the differences in the categorical frequencies of household water-user preferences and sustainable supply of water are too small, and any differences thereto could be explained by chance. The alternative hypothesis Ha_4 that household water-user preference in the slums is dependent on the sustainable supply of water was therefore accepted. It can therefore be deduced that the way water is used depends on its sustainable supply in the slums. The residents of the slums prefer to use water depending on its sustainable supply.

5. Discussions and Conclusions

5.1. Discussions

The study thus established that household water-user preference in the slums is generally poor. This means that the UN (2009) ratios on the water that is recommended for use on personal washing, gardens, laundry, toilets, car washing, dishes, cooking and drinking are not followed, because people are not aware, or they cannot follow these ratios.

This failure to use water wisely could be one of the causes of water insecurity in Obunga slums. This would mean that the view of Levine and Asano (2004) on grey water recycling is not taken seriously by the households in the slums. Grey water, or sullage, recycling is the reuse of water from the sinks, showers, washing machine and dishwasher in a home. Hence, it can be said that households in the slums do not separate grey water and black water, to send black water to conventional wastewater treatment systems, while sending untreated grey water for outdoor washing and irrigation. This is a threat to water security. Further, as WHO (2006) also note, methods of lowering demand on water supplies and attain water security such as the collection of rainwater for domestic water consumption have been ignored.

As espoused by Spings *et al* (2011), feeling a sense of personal moral obligation to conserve water is an important determinant of overall water curtailment and efficiency intentions and intentions to install specific water efficiency devices. A link should be developed between individual actions and the collective outcome and those that emphasize the responsibility of all citizens to address the issue of water conservation often help to develop this sense of moral obligation. Householders should also feel confident that they can easily engage in water conserving practices by encouraging household members and others install water efficient appliances and to develop householders' confidence and efficacy. Often, actions that we engage in repetitively become habits. By promoting water conservation and disrupting water wasting habits and replacing these with water saving habits is a way of ensuring sustainable supply of water.

Similarly, in the view that majority of households have a moderate supply of safe water, water insecurity that has been reported in the informal settlements is attributable to lack of water conservation behaviour on the side of household members. According to Dillon (2011) installing rainwater tanks increases the amount of water that is captured usefully and enables households to harvest water directly for drinking, gardening, cooking and washing, etc. Another strategy is to increase the capacity to store water using large reservoirs tanks that can last for at least 5 days with a family of 4 members. The observation by the researcher revealed that families in Obunga slums only store water in 20 litres plastic containers, and this cannot take these families even for a day.

5.2. Conclusions

With regard to sustainable supply of safe water to residents of slum areas, a number of steps can be taken which can limit excesses on the side of household water users that interfere with water supply. Poor water-user preference causes water insecurity which in turn leads to spread of water borne ailments. In this regard, household in informal settlements use water depending on the sustainability of water supplied to them. This often leads to these households into using water for domestic use from unprotected and unsafe sources.

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